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VOLUME 26 | DECEMBER 13, 1937 | NUMBER 25

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VOLUME 26 DECEMBER 13, 1937 NUMBER 25

Synthetic Aliphatic Penetrants*

B. G. WILKES† and J. N. WICKERT**

An increasing interest in the use of compounds possessing surface activity has taken place during the past few years. Among such compounds the sodium secondary-alcohol sulfates have lately become available to industry in quantity. The chemical structures of these and a number of other compounds possessing surface activity are described. A comparison is made of their relative wetting action, surface tension, and lime soap dispersibility under neutral, acid, and alkaline conditions. In addtion, some commercial applications in which these sodium secondary-alcohol sulfates are or can be used to advantage are briefly described.

A LARGE growth of interest in organic compounds possessing properties of surface activity in aqueous systems has occurred during the past five years. Currently this interest is greater than ever before, as evidenced by the many patents issued on the manufacture of polar or surface-active compounds intended for use as wetting agents, penetrants, detergents, emulsifying and spreading agents, and for a host of other industrial applications where aqueous processes are utilized.

Closely paralleling this growth in the commercial availability of such products have been industry's acceptance and usage of them. It is difficult to decide whether demand created the marked interest in their manufacture or whether intensive educational efforts by producers rapidly popularized already available commodities. It is true, nevertheless, that industry is becoming increasingly conscious of the importance of the chemistry of surface activity in respect to its aqueous processes and the advantages to be gained by the use of these many new polar compounds. As a result many industries devoted to textiles, leathers, insecticides, paper, ceramics, pharmaceuticals, metals, paints, cosmetics, oils, and gases are realizing significant reductions in processing time and improvements in results.

This general class of chemical compounds first found application in the textile field. Its commercial origin goes back to the interest of this industry in the development of improved substitutes for soaps and sulfonated oils. It was desired to eliminate the sensitivity of soaps to water hardness and acidity, which are frequently encountered in operations where the surface-active properties of soap solutions are of prime importance. The chemical structure of soap-like materials and the relation of their molecular structure to properties of surface activity, or surface and interfacial tension reduction, are generally understood and widely accepted. Soaps and compounds which function similarly in aqueous solution are strongly polar compounds, comprising a non-polar hydrocarbon portion of high molecular weight, at some point in which is located a sufficiently polar or water-soluble group to endow the molecule with properties of at least colloidal solubility in water. The position of this hydrophyllic group in the molecule may vary; but in soaps and soap substitutes which are derivatives of fatty materials, this group is generally a primary one located at the end of a long straight-chain hydrocarbon molecule. Since this polar group is responsible for the sensitiveness to the presence of calcium and other alkaline earth salts, elimination of this disadvantage can be accomplished by chemical alteration of this group. One of several methods by which this result is now effected is by hydrogenation of fats and fatty acids, followed by sulfation of the resulting fatty alcohols. The materials thus produced are primary alcohol sulfates and closely resemble the normal soaps, prepared from the same raw products, in such practical exhibitions of surface activity as detergency, wetting, emulsifying action, and penetration.

In view of the modern conception of the workings of such surface-tension depressants, it was reasonable to suspect that secondary aliphatic alcohols of high molecular weight might also exhibit interesting and useful properties of surface activity when made soluble and strongly polar by formation of their sulfate esters. Pursuit of this idea led to the preparation of a series of purely synthetic, sec-

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†Mellon Institute of Industrial Research.
**Carbide and Carbon Chemicals Corporation.

ondary aliphatic alcohols containing from 10 to 21 carbon atoms in which the hydroxyl groups are located on carbon atoms near the center of the hydrocarbon chains. By sulfation of these alcohols and neutralization of the resulting acid alcohol sulfates, a group of sodium secondary-alcohol sulfates was obtained which have subsequently been found to possess very remarkable properties of wetting and penetration, the magnitude of which appears to be conditioned primarily by the size of their non-polar hydrocarbon groupings.

The results of a complete study of the factors affecting the commercial production of this series of synthetic penetrants, and consideration of the effectiveness of the wetting action of each member of the group, indicated that several sodium alcohol sulfates containing hydrocarbon groupings of various size would be necessary to obtain optimum performance over the wide range of conditions imposed by the variety of specific industrial applications for penetrants. Accordingly, this group of products has been made available in water solution under the name "Tergitol."* For the sake of simplicity, these sodium alcohol sulfates will be designated as Tergitol 7, Tergitol 4, and Tergitol 08, and the tabulated concentrations of these materials, unless otherwise noted, will refer to the products as they are marketed.

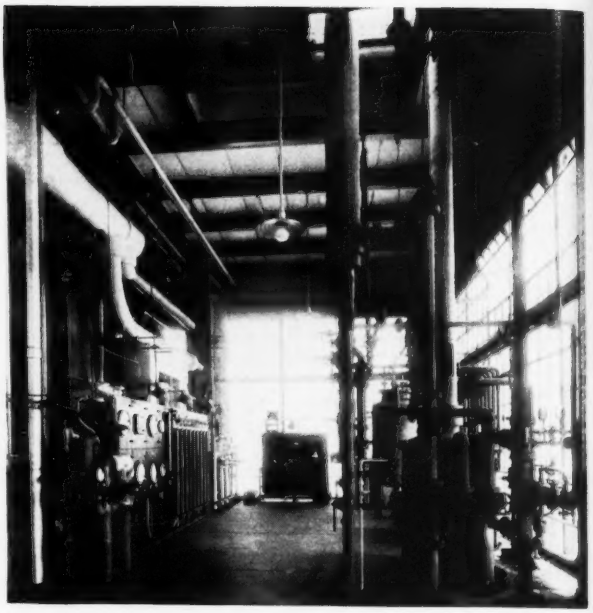
Upon examination of the wetting and penetrating action of the Tergitol products and a representative list of the other structural types of commercially available, surface-active compounds, it became apparent that the position of the hydrophyllic or polar groups, with respect to the non-polar portion of the molecules, could be correlated with somewhat distinct differences in the wetting efficiency of the materials. On the basis of these differences it is possible to divide the investigated products into two classes, each of which has its own peculiar and outstandingly useful properties. The following tabulation shows the chemical structure of the types comprising these two groups:

Type No.	*Group A*[a]	*Type No.*	*Group B*[a]
A-1	R—COONa	B-1	R'_2CHSO_4Na
A-2	R—SO_4Na	B-2	R'OOC—CH_2 / R'OOC—$CHSO_4Na$
A-3	R—$CONHC_2H_4SO_4Na$		
A-4	R—$COOC_2H_4SO_4Na$	B-3	R'Ar—SO_3Na

[a] R = fatty alkyl group; R' = primary or secondary non-fatty alkyl group; Ar = aryl or aromatic group.

In group A are listed the various types derived from fatty sources—specifically, soaps, fatty alcohol sulfates, and sulfated fatty acid esters and amides. The polar or water-soluble groupings in all these compounds is a primary one, located at the end of the non-polar portion of the molecule. In contrast, group B presents the available types of the more truly synthetic surface-active compounds, including the secondary alcohol sulfates, sulfated esters of higher alcohols and dibasic acids, and the numerous alkyl derivatives of aryl or aromatic sulfonates. Each of these types contains its polar group in a secondary position with the non-polar portion extending from it in two directions.

*Trade-mark registered.



Equipment Bay of Plant in Which Tergitol Compounds Are Manufactured

Foaming is one of the characteristic phenomena of aqueous solutions of soaps and similar polar compounds. As pointed out by Adam[1] and McBain[12], the uniform molecular alignment and packing of the long hydrocarbon chains found in adsorbed films of soaps and other compounds of group A are largely responsible for the unusual stability of the foams they produce. The extent of alignment or packing of molecular films, and their consequent toughness, is influenced by the position of the polar group within the molecule, according to Adam and Rosenheim[2], who show that the molecular area of adsorbed films of isomeric sterols varies markedly with the position of the molecule of the water soluble hydroxyl group. The film toughness and foam stability of capillary active compounds should, therefore, be expected to be influenced by the molecular position of the polar group. Furthermore, investigators agree[5] that the effective emulsification and emulsion stability are dependent not only upon the reduction of interfacial tension, but also upon the film toughness of the emulsifying agent. Inasmuch as emulsification is an important factor in detergent operations[13], it follows that scouring or cleaning efficiency, as well as emulsifying action, is also influenced by the position of the hydrophyllic group in surface-active molecules. The classification of compounds on the basis of polar group position, as shown in groups A and B, is justified from experimental observations on their wetting action, detergency, and foaming action.

The remarkable detergent and emulsifying actions of soaps are generally known. That these properties are also characteristic of other members of group A has been widely recognized[4, 7, 10, 14], with the result that they are now popular substitutes for soap in scouring and dispersing applica-

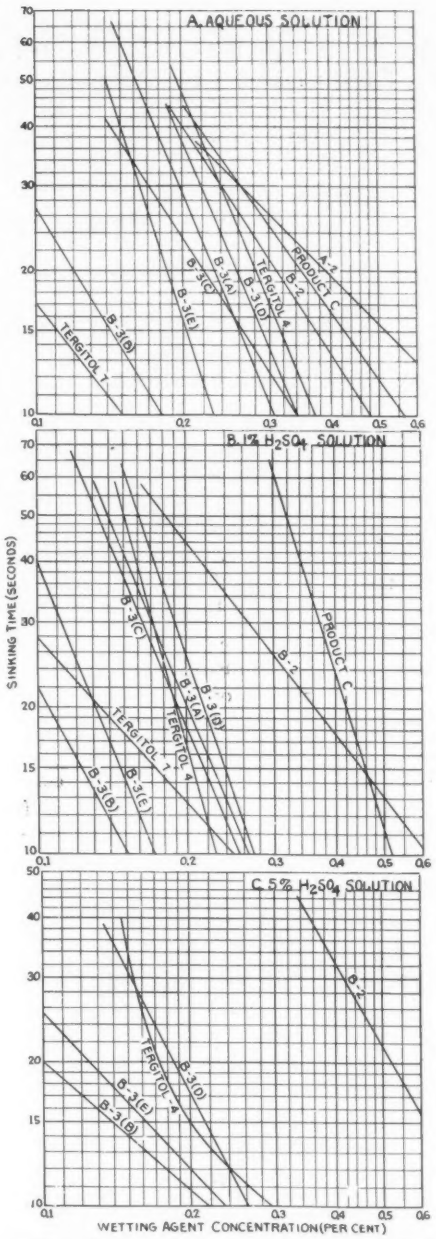


Fig. 1. Cotton Wetting Action of Commercial Penetrants in Aqueous and Sulfuric Acid Solutions at 25° C.

tions. Although group B members are somewhat inferior in this respect to the primary polar compounds of group A, they have been shown in this investigation to be decidedly superior to the latter in the role of wetting agents and penetrants. Although it is accepted that low interfacial tension is a prime requisite for wetting and penetration, there are also other unmeasurable factors which influence the wetting activity of these compounds, particularly for textile fibers. This contention is fully supported by the work of Lenher and Smith[11] and corroborated by observations made during the present investigation. In aqueous systems containing compounds of groups A and B and possessing equivalent surface and interfacial tension values, solutions of the group B secondary polar compounds have consistently shown wetting and penetration activities superior to those of the primary polar compounds of group A. This conclusion is based upon the results obtained in evaluating as wetting agents a long list of commercially available penetrants which included representatives of each of the various chemical types comprising both the primary and secondary polar groups.

COMPARATIVE WETTING ACTION OF VARIOUS PRODUCTS

The phenomena of wetting and penetration by aqueous media are probably of more general importance to the textile industry than to any other industrial field. It is not surprising, therefore, that many test methods have been suggested and used for the evaluation of the ease with which textile commodities, such as yarn and fabrics, may be wetted. The test procedure used in the present investigation since its origination by Draves and Clarkson[6] has been adopted by the American Association of Textile Chemists and Colorists as its standard method[3]. It entails determination of the time required for 5.0-gram skeins of two-ply unboiled cotton yarn to sink when weighted with a 1.5-gram sinker and submerged in wetting agent solutions by means of an anchor. When observed sinking times are plotted on a log-log scale as a function of wetting agent concentrations, a straight-line relation is obtained. The results of such wetting tests, covering a sensible range of wetting agent concentrations, are presented in Figs. 1 and 2. The curves were obtained by the use of commercially available penetrants in the form in which they are marketed. The curves of Fig. 1 represent the wetting efficiencies in aqueous solutions of all the products tested that were active enough wetting agents to produce cotton sinking times of approximately 12 seconds at wetting agent concentrations of 0.6 per cent or less. The chemical type of wetting agent used in determining the individual curves can be obtained by comparing the curve designations with the above type classification. One product, because of its questionable composition, is designated on the charts as product C.

TABLE I

Concentration of Wetting Agent Necessary to Produce 12-Second Sinking Times at 25° C.

Wetting Agent Type	*Water Soln.*	*1% H_2SO_4 Soln.*	*5% H_2SO_4 Soln.*	*0.5% NaOH Soln.*	*1% NaOH Soln.*	*2% NaOH Soln.*
	Per Cent by Weight					
B-3 (A)	0.28	0.25	...	...	...	...
B-3 (B)	0.16	0.14	0.18	...	...	...
B-3 (C)	0.30	0.24	...	0.39	0.38	0.46
B-3 (D)	0.32	0.26	0.24	0.33	0.29	...
B-3 (E)	0.22	0.16	0.20	0.20	0.19	...
B-2	0.43	0.53	...	...	...	...
Product C	0.50	0.49	...	0.58	...	...
B-1 (Tergitol 7)...	0.13	0.21	...	0.22	...	...
B-1 (Tergitol 4)...	0.34	0.22	0.24	0.32	0.19	0.19

Fig. 1*A* shows that the most efficient wetting agents are those whose sinking time-concentration curves lie in the region closest to the origin of the axes. The secondary alcohol sulfate product, Tergitol 7, was the most unusual in this respect; other products, which are also compounds of the secondary polar group B, were closely related to it in point of wetting efficiency. In contrast to these findings, it is interesting to note that only one product of the primary polar group A showed sufficient wetting merit to be represented by a curve in Fig. 1*A*, and the position of the curve (A-2) on the chart is indicative of only mediocre efficiency.

A useful comparison of the activity of these textile assistants can be obtained by tabulating from these charts the concentrations of the various products necessary to produce equal and arbitrarily chosen sinking times. The results of such a procedure are summarized in Table I, which shows the concentrations of the wetting agents necessary to realize 12 seconds sinking time in aqueous solution and under different conditions of acidity and alkalinity.

Blank spaces in Table I indicate sinking times greater than 12 seconds at all concentrations less than 0.60 per cent.

Table I and Figs. 1 and 2 reveal that the wetting efficiency of all the products studied changes appreciably as the acidity and alkalinity of the wetting medium are altered. Instability of the wetting agent is the causal factor in some instances, such as that of type B-2 which, because of tis contained ester groupings, readily decomposes in alkaline solution. A more general reason than instability, however, is the variation in effective solubility of the compounds and in their properties of surface activity. Thus, the unusual wetting efficiency of Tergitol 7 is limited to solutions of relatively low alkalinity and acidity because only in this region is it satisfactorily soluble. On the other hand, Tergitol 4 is suitably soluble over a much wider range and becomes a progressively better wetting agent as solution alkalinity and acidity are increased, probably because of the greater surface activity which these changes induce. The limiting strength of sulfuric acid solutions in which Tergitol 4 is suitably soluble is, however, about 5 per cent, which accounts for the curvature of the line representing this product in Fig. 1*C*. Tergitol 08 is soluble even in such aqueous systems as the 25 per cent sodium hydroxide solutions used in cotton mercerizing processes, to which it imparts wetting properties of high merit and stability.

SURFACE ACTIVITY OF ALCOHOL SODIUM SULFATES

Mention has been made of the invalidity of surface and interfacial tension values as the principal criteria of the wetting and introfying action to be obtained with aqueous solutions of these polar compounds. Results in definite agreement with this contention were the outcome of an investigation of the interfacial tensions existing between kerosene and aqueous solutions of primary and secondary alcohol sulfates, ranging in carbon content from 12 to 19 atoms per molecule. Measured volumes of aqueous solutions of the various alcohol sodium sulfates were allowed to flow into kerosene through a carefully machined brass tip of accurately known outer diameter, and the numbers of drops formed were determined. The drop volumes were corrected to the ideal drop volume by the method of Harkins and Brown[8] and the interfacial tension values shown in Fig. 3 were calculated from the equation:

$$\gamma = \frac{V(D_a - D_k)g}{2\pi r}$$

where γ = interfacial tension, dynes/cm.
V = ideal drop volume, cc.
D_a = density of aqueous solution, grams/cc.
D_k = density of kerosene, grams/cc.
g = acceleration due to gravity, dynes
$2\pi r$ = circumference of tip, cm.

Carefully purified sodium alcohol sulfates, rather than commercial wetting agents, were used to obtain the data from which the curves of Fig. 3 were constructed. Curves 3 and 4 show that the sodium primary- or fatty-alcohol sulfate solutions show lower interfacial tensions against kerosene than do those of the sodium secondary-alcohol sulfates containing an equivalent number of carbon atoms when the alcohols contain less than 18 carbon atoms. Wetting tests, however, performed both on commercial products and purified materials of this type, demonstrate that the sodium secondary-alcohol sulfates are decidedly superior to the primary compounds in point of effective wetting activity. Another example of this inconsistency is the observation that the standard wetting time for cotton by a textile soap solution having a du Noüy surface tension of 30.9 dynes per cm. at 25° C. is more than three times as great as that of a solution of Tergitol 7 having the same surface tension.

The surface tension of aqueous solutions of the Tergitol penetrants decreases as the molecular carbon content of the alcohol sulfates is increased. The extent of surface tension reduction also becomes greater as the concentration of these penetrants is increased and as the solution pH is varied on either the acid or alkaline side of the neutral region. The dependence of surface tension upon Tergitol concentration, as measured by the du Noüy tensiometer, is shown in Fig. 4; the effect upon this property of changes in solution pH is demonstrated by the curves of Fig. 5. Indicators, particularly tested for accuracy in the alkaline region, were used in the colorimetric pH measurements.

As long as the solubility characteristics are not altered thereby, the wetting activity of sodium secondary-alcohol sulfates becomes progressively greater as solution acidity or alkalinity is increased. This characteristic is clearly demonstrated by the concentration values of Tergitol 4 (Table I) which rise from minimum values in acidic and basic solutions to a maximum value in neutral range. Still more striking is the effect of increasing alkalinity upon the surface activity and wetting action of Tergitol 08. This sodium alcohol sulfate possesses practically no wetting activity in sodium hydroxide solution until the concentration of the latter is raised to about 10 per cent, but becomes a

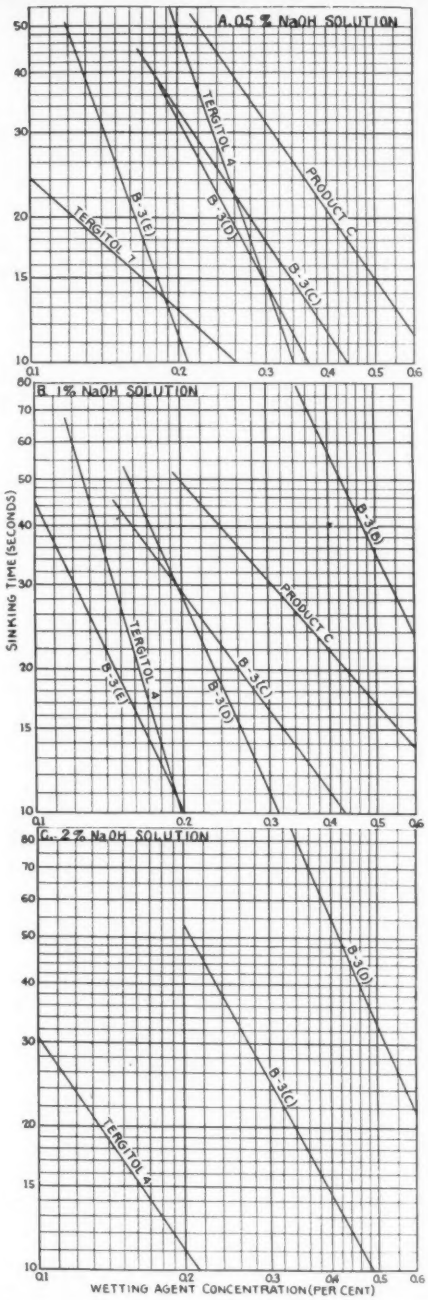


Fig. 2. Cotton Wetting Action of Commercial Penetrants in Sodium Hydroxide Solutions at 25° C.

progressively improved penetrant as the concentration of alkali is further increased. The gradually lowered surface tension which parallels this improvement in the wetting action of various sodium hydroxide solutions of Tergitol 08 is shown by the following experimental data:

NaOH Concn. Weight %	*Tergitol 08 Concn. Weight %*	*Surface Tension* Dynes/cm.*	*NaOH Concn. Weight %*	*Tergitol 08 Concn. Weight %*	*Surface Tension* Dynes/cm.*
1.0	0.5	45.0	15.0	0.5	30.6
2.0	0.5	41.7	25.0	0.5	29.7
5.0	0.5	34.5	25.0	..	75.8
10.0	0.5	31.7			

* du Nouy determinations at 25° C.

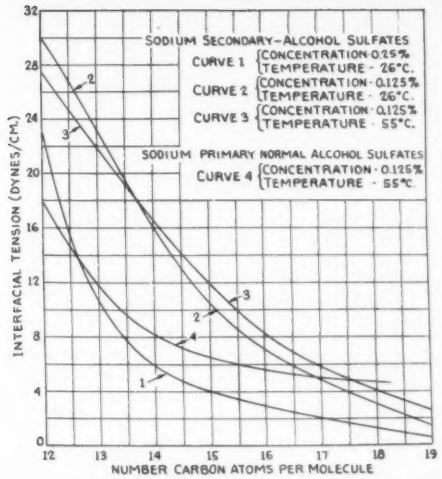

SODIUM SECONDARY-ALCOHOL SULFATES
CURVE 1 {CONCENTRATION 0.25% TEMPERATURE - 26°C.
CURVE 2 {CONCENTRATION - 0.125% TEMPERATURE - 26°C.
CURVE 3 {CONCENTRATION - 0.125% TEMPERATURE - 55°C.
SODIUM PRIMARY NORMAL ALCOHOL SULFATES
CURVE 4 {CONCENTRATION - 0.125% TEMPERATURE - 55°C.
INTERFACIAL TENSION (DYNES/CM.)
NUMBER CARBON ATOMS PER MOLECULE

Fig. 3. Interfacial Tension at Boundary of Kerosene and Aqueous Sodium Alcohol Sulfate Solutions

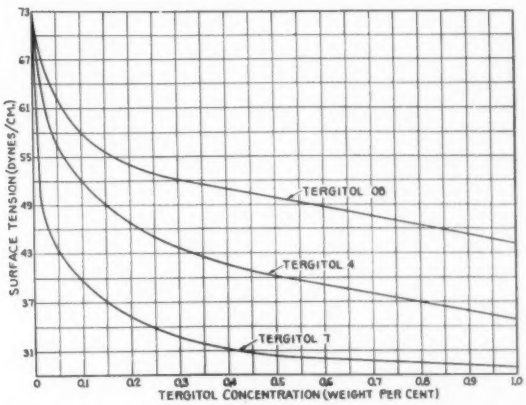


Fig. 4. Surface Tension of Aqueous Tergitol Solutions at 25° C.

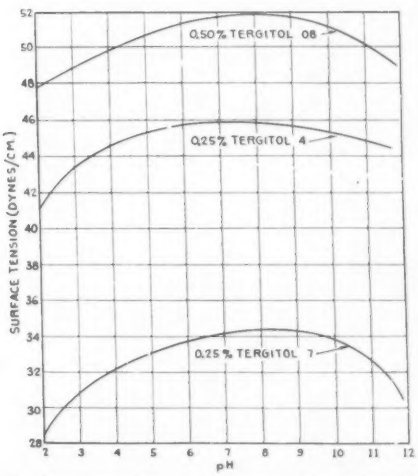


Fig. 5. Surface Tension of Aqueous Tergitol Solutions at Various pH Values (25° C.)

Tergitol 08, like Tergitol 4, is exceptionally stable under alkaline conditions. The wetting ability of the former is not diminished when its solutions, containing 25 per cent sodium hydroxide, are kept at their atmospheric boiling temperature for several hours.

STABILITY UNDER CONDITIONS OF INDUSTRIAL USAGE

A number of industrial processes in which wetting, spreading, and introfying accelerators are finding wide application necessitate their stability in the presence of acids and alkalies. Wool carbonizing, acid fruit washing, cotton kier boiling, acid treatment of oil wells, and many dyeing operations are only a few on a large and constantly extending list. In view of the pronounced stability of each Tergitol in acidic and alkaline media, the choice of a particular member of this group of compounds for use under such conditions is dependent only upon its solubility and degree of wetting efficiency.

Resistance to the destructive action of oxidizing agents is a point of merit especially desirable in penetrants which are employed in such textile operations as peroxide and hypochlorite bleaching. Tests of the stability of Tergitol 4 under the conditions encountered in textile bleaching with sodium hypochlorite were made and compared with the results of similar tests in which the penetrant used was of the alkyl aromatic sulfonate type (B-3). The original wetting efficiency of a 0.50 per cent solution of the latter product in an aqueous medium containing 3 grams per liter of available chlorine was measured. These tests were repeated periodically as the solution was aged for 5 days. During this time the wetting efficiency gradually decreased and, at the end of the 5-day test period, 75 per cent of the amount of the penetrant originally used had to be added to restore the solution's initial wetting efficiency. A 0.50 per cent solution of Tergitol 4, under identical conditions of test, retained completely its initial wetting activity throughout the 5-day period.

Much importance has been attached to the metallic salt solubilities of the many polar compounds offered to industry as soap substitutes for wetting and detergent operations. Under conditions of actual usage of the sodium alcohol sulfates, the solubility of their calcium salts in water is not a dependable measure of the resistance of these materials to the action of hard water[10] because their calcium salts have an apparently greater solubility in water solutions of their sodium salts than in water alone. This action of the sodium alcohol sulfates in dispersing their calcium salts is responsible for their so-called hard-water resistance. The few published methods for evaluating this property are empirical and give results which are comparative rather than absolute. A modification of the method outlined by Hart[9] was employed in experiments designed to give a comparative picture of the calcium stability, or "lime-proofness," of the Tergitol products and other commercial wetting agents and detergents. The test procedure consisted of titrating 40 cc. of 0.50 per cent solutions of the products in a 100-cc. beaker with a 1.00 per cent solution of calcium acetate. The degree of developed turbidity, which just obscured typewriter print on paper fastened to the side of the beaker and viewed horizontally through the solution, was taken as the end point of the titrations. Stronger solutions of calcium acetate were used in some of the titrations in order to keep the final volume of the test solutions in all cases under 45.0 cc. The results of these tests, translated into degrees of solution hardness at the same end point for all the wetting agents tested at 25° C., are as follows:

Wetting Agent Type	*Solution Hardness as $CaCO_3$, P. P. M.*	*Wetting Agent Type*	*Solution Hardness as $CaCO_3$, P. P. M.*
A-1 (olive oil soap)	25	A-2	1070
B-3	100	B-1 (Tergitol 4)	1380
B-1 (Tergitol 7)	100	A-3	5630
B-2	888	B-1 (Tergitol 08)	End point unobtainable

Although a number of uncontrollable experimental factors limit the precision of these values, their range in magnitude is so great that they may well serve as an indication of the comparative hard-water resistance of the materials tested. Although the calcium stability of Tergitol 7 is appreciably greater than that of soap, it is decidedly less than that of the primary polar types A-2 and A-3 and of Tergitol 4 and Tergitol 08.

Additional observations suggest the utility of both Tergitol 4 and Tergitol 7 in dispersing or preventing the precipitation of lime soaps. Preliminary tests along this line indicate that lime-soap dispersing action, superior to that of the fatty-alcohol sulfates and other primary polar textile assistants, may be obtained with the sodium secondary-alcohol sulfates. Some results of initial nephelometric titration tests at 25° C. patterned after those outlined above for the determination of calcium hardness and performed on olive oil soap solutions containing various proportions of Tergitol 4, Tergitol 7, and two other textile assistants are as follows:

Olive Oil Soap Concn. %	*Wetting Agent Concn. %*	*Hardness as $CaCO_3$ at Nephelometric End Point*			
		A-3	*A-2*	*B-1 (Tergitol 4)*	*B-1 (Tergitol 7)*
		Parts Per Million			
0.50	0.05	169	186	160	211
0.50	0.10	163	197	196	205
0.50	0.25	165	213	236	217
0.50	0.50	155	201	264	223

0.50% olive oil soap (blank determination) = 136.

The ability of Tergitol 4 and Tergitol 7 to increase the tolerance of soap solutions for calcium hardness is clearly indicated by these values. As the ratio of wetting agent to soap is increased, the lime-soap dispersing action of Tergitol 4 becomes superior to that of Tergitol 7. This phenomenon is to be expected in view of the greater lime stability or greater apparent calcium salt solubility of Tergitol 4. This ability of the Tergitol compounds to prevent the agglomeration and precipitation of hard-water soaps has already been shown to possess practical utility in such detergent operations as laundering and shampooing.

In the alkali salts of the higher secondary-alcohol sulfates synthetic aliphatic chemistry has made available to industry a series of products whose properties of surface activity are significantly different from those of the primary polar compounds of fatty origin. Because of their

unusual powers of wetting and penetration and their stability under conditions of industrial usage, numerous problems in the sphere of aqueous penetration and spreading are already being solved through the application of these novel polar compounds.

Studies are in progress to evaluate further their detergent powers as well as their ability to emulsify and act as dispersing agents. Just as in the case of soap, it has already been found that certain addition agents will act as builders and augment their foam-producing powers. Other metallic and amine sulfates of these higher synthetic alcohols have been prepared to compare their properties with those of the sodium derivatives. So far, insufficient differences have been found to warrant their commercial exploitation.

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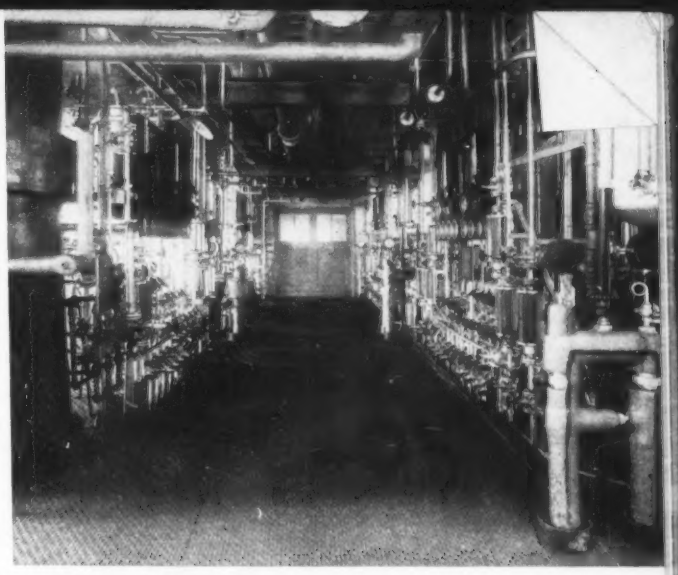

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Degree of Whiteness

Obtainable by Bleaching

Its Relation to Varieties of Cottons

G. B. JAMBUSERWALA, M.Sc. Tech., (Manc.)*

INTRODUCTION

ALTHOUGH the object of bleaching, according to the scientific view, is the removal of impurities from cotton fiber, nevertheless, is a recognized fact that commercially great importance is attached to the production of perfect white in the material without sacrificing its textile qualities and which will not yellow by storage or ironing. The degree of purity obtainable through bleaching is not always coincident with the degree of whiteness, that is the extent of purity attained many times fails to serve as an index of whiteness produced on the material. However this aspect of the problem, namely, the degree of whiteness produced in bleaching and its relation to differences in varieties of cottons has received little attention from previous workers since most work hitherto published mainly seeks to give quantitative determinations of the extent of modification introduced in the cellulosic fiber.

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In the first instance mention may be made of a few of the large number of reagents like Nessler, alkaline solution of silver nitrate, Fuchsine salt, phenyl-hydrazine, etc., that are employed to test qualitatively the purity of cotton fiber. These are of little value for estimating quantitatively the textile quality of a bleached material. Besides these, there are other important methods of determining the purity of the bleached material.

(1) The "Wood-gum Value" representing the residual substances in bleached material that are soluble in 5 per cent caustic soda solution.

(2) Viewig's "Acid Value" test, which measures the amount of caustic soda neutralized by a bleached sample when boiled in its solution.

(3) The Freiberger's "Methylene Blue Number" which measures the depth of Methylene Blue dyeing, and incidentally indicates the extent of impurities present in the test sample[1].

(4) The extent of bleaching expressed by Chemical

Numbers which are mostly based upon the determinations of the reducing properties of the fiber in an alkaline liquor. (a) Schwalbe's "Copper Number" determines the quantity of copper reduced in Fehling solution by cellulose and gives the measure of the purity of fiber[2]. This method has been simplified and made satisfactory by Braidy[3]. (b) Kauffmann's "Permanganate Number" determination which indicates the reducing property of the alkaline extract of the fiber compared with permanganate[5]. (c) Goetze's "Silver Number" which gives a measure of purity of fiber by estimating the quantity of silver separated from its salt solution[6]. (d) Freiberger's "Ferricyanide Number" which gives the quantity of ferricyanides that the fiber reduces[7]. It is however pointed out that these Chemical Numbers break down when very slight changes have taken place or when fiber decomposition products have been removed by alkalies.

(5) A more precise measure of determining the purity state and chemical condition of bleached material has been suggested by Clibbens and Geake in "Viscosity" determinations of cellulose in cuprammonium solution. The fluidity of this solution gives a very accurate measure of the textile quality of the fiber[8].

This list of methods dealing with attempts to measure the efficiency of bleaching processes is not exhaustive; even a bibliography of all the work which is very extensive, cannot be given here beyond the citation of the recognized methods that are commonly employed. It must be pointed out that these methods only give an indication of the purity state and chemical modification suffered by cellulose and are not useful for determining the degree of whiteness in bleached material. When therefore a bleached material has proved from these enumerated tests that it has suffered no degradation in regard to its textile qualities, there remains one other important consideration to guide process work, namely the attainment of white in bleached material.

So, the chemical control of bleaching demands that physical methods be resorted to for determining the degree of whiteness. In the past, however, very little work has been done to study the practical aspect of this question. The nearest approach to a physical determination for judging degrees of whiteness obtained in bleaching is to be found in the work of Freiberger. He has shown how the whiteness of bleached material could be standardized by observation of stains produced on test samples by waste kier liquors diluted to known strengths. He asserts that 5 per cent differences in bleaching could be determined by comparison with standard samples, ranging from white to gray unbleached[9]. Haller criticizing this investigation is of the opinion that the method is applicable if the same system of bleaching and identical conditions in kiering are maintained[10]. Admittedly there is much validity in this statement of Haller because standard samples will fail to indicate the extent of whiteness if the goods are manufactured from different varieties of cottons or have not the same twist content in yarns or in the case of woven goods, they are made of different weaves.

OBJECTS OF THE PRESENT INVESTIGATIONS

1. To ascertain the purity of bleached samples by estimating the residual ash and fatty matter contents in the samples on the lines originally suggested by Dr. Ambuhl[11].

2. To estimate the degree of whiteness in bleached samples by measuring the intensity of daylight reflected from their surfaces using for the purpose a photo-electric cell equipment provided with an amplifier and a galvanometer.

3. To correlate the last two determinations with visual estimation of differences in whiteness in different varieties of cottons.

It should be observed that the determination of ash content in bleached material indicates not only the purity state of the fiber but also the feel of the material. Likewise the residual fatty matters give a measure of absorbtive capacity of the material under test. Moreover, these two chemical determinations furnish the additional information as to what extent the material is liable to yellow on storage. Hence, whilst aiming at a perfect white these tests are to be preferred to those previously mentioned, (which mainly determine the modification caused in cellulose by bleaching operations).

With reference to the second objective it would not be out of place to preface here some of the instruments that have been employed in recent years for determining the color value of surfaces. In practice the measurement of the reflection coefficient is effected either by (1) visual comparison of color surfaces, or (2) direct measurement of light intensity on suitable instruments.

In the first method of visual comparison of surfaces, color of the test sample is matched against another surface of known value. Here the human eye is employed as a detector of equality. The simplest instrument for such comparison is a tintometer which helps the eye in comparing the colors. Then we have "Trichromatic" and "Monochromatic plus White" colorimeters. In case of the first the color of the sample is matched by adjusting the relative amounts of red, blue and green light obtained from three color filters[12]. Whilst the Monochromatic colorimeters effect a match by mixing monochromatic light with white light; and these measure the saturation and hue directly[13]. It is well known that to obtain a match against a white surface is very difficult with these instruments and personal factor does not play an unimportant part in such matching. In recent years, special instruments have been devised to match nearly white materials. When however an instrument such as the "Cube Photo-meter" is used, it is pointed out that though it is capable of differentiating color values, it has the disadvantage that it requires a large area of surface under examination. Also its results are in no way comparable with direct visual examination because the Cube Photo-meter readings depend upon the sum total of light reflected from the test

sample in all directions and are relative to the direction of incident and reflected light, whereas those of visual only take account of a single sensation for a particular angle of incidence and reflection. To overcome this difficulty a photo-meter has been evolved known as a "green" cell by Westinghouse, Brake & Saxby Signal Co., and this is able to measure the diffused reflected light of a surface under conditions more comparable with those of direct vision and requiring a smaller area[14]. There is besides Zeiss Step Photometer in which the yellow color of the bleached sample can be counter-balanced by a complimentary color such as blue. At the same time it could be employed to analyze the three fundamental colors of which white is composed[15]. Finally, Hilger's Blancometer is employed for the measurement of color in nearly white goods. This instrument depends upon the human eye, for the observer himself has to decide whether two color fields are of the same intensity. Thus these instruments are subject to personal equation for the accuracy and sensitivity depend upon the sensitivity and accuracy of the eye[16].

In the second method of direct measurement of light intensity on suitable instruments, it is suggested that the emergent light could be measured by means of direct reading instruments. The most suitable equipment to employ for the purpose is the photo-electric cell of high sensitivity to all ranges of spectrum provided with an amplifier and a galvanometer to give direct readings instead of the human eye being used to decide the matching of observed fields. The measurements thus obtained for bleached samples could be compared with those of a standard white surface free from subjective errors. Lastly, instead of measuring the color in terms of color, it can be measured in terms of wave length by means of Spectrophotometers. These measure the proportion of incident light that is reflected from the test sample at each wave length of the visible spectrum[17]. Further instead of illuminating the test sample with white light, a prism or some other suitable device be inserted in the incident beam so that the sample is illuminated by monochromatic light whose wave length is adjustable. Also it is possible to replace the eye of the observer by some physical detector like a photoelectric cell. Thus the modified instrument provides the only method of color measurement and specification, for the wave length (shape) curve of the intensity of light reflected by the test sample is a fundamental physical property of the sample and is independent of illuminant and the observing eye[18]. Spectrophotometers maintain a very high accuracy for discriminating colors which are nearly white as compared with other optical instruments described, but only at the expense of a considerable amount of time and this is a serious drawback for their use in the industry.

EXPERIMENTAL

It is common knowledge that cottons of different origins bleached under identical conditions using the same scouring and bleaching agents do not give the same degree of whiteness. With a view therefore to indicate the degree of whiteness obtainable in different varieties of cotton by bleaching, five varieties of cottons were used for experimental purposes, namely two varieties of Indian cottons and three others, Egyptian, Uganda and American cottons.

Firstly, a set of samples comprising the five varieties of cottons were scoured with caustic soda and sodium carbonate without using any saponifiable agent like turkey red oil or soap.. Secondly, another set of the five varieties of cottons was scoured with caustic soda, sodium carbonate and turkey red oil. Subsequently, the two lots of scoured samples were bleached with (1) Perchloron (calcium hypochlorite containing 68 per cent of available chlorine); (2) Sodium hypochlorite; (3) Hydrogen peroxide; and (4) Sodium peroxide as bleaching agents. Thus the two lots were obtained, each constituted of the five varieties of cottons, bleached with the above four bleaching agents, but differing in regard to the scouring treatment given to them before bleaching. Experimental details of scouring and bleaching are given in Table I.

TABLE I

Set No. I

Hanks of five varieties of cotton were scoured with 2% caustic soda and 3% sodium carbonate solution for 8 hours at 15 lbs. pressure in a kier.

Set No. II

Hanks of the five varieties of cotton were scoured with sodium hydroxide, 3% sodium carbonate and 1% Turkey red oil (50%) for 8 hours at 15 lbs. pressure.

Sets No. I and II

Perchloron Bleach: The scoured material was bleached with a perchloron solution containing 2 g. of free chlorine per litre, for 30 minutes, rinsed, scoured with 1% hydrochloric acid, rinsed, etc.

Sodium hypochlorite bleach: The scoured material was bleached with a sodium hypochlorite solution containing 2 g. of free chlorine per litre for 30 minutes, rinsed, soured with 1% hydrochloric acid, rinsed, etc.

Hydrogen peroxide bleach: The scoured material was bleached with hydrogen peroxide of 2 vol. concentration, adding 7 g. of sodium silicate plus 3 g. of Igepon T per litre as stabilizers. Bleaching was started in cold and slowly raised to 60° C. in two hours time; rinsed, soured with 1% hydrochloric acid, rinsed, etc.

Sodium peroxide bleach: The scoured material was bleached with sodium peroxide, first converting up the latter into hydrogen peroxide by the help of sulfuric acid, and then the concentration of hydrogen peroxide was reduced down to 2 vols. 7 g. of sodium silicate plus 3 g. of Igepon T per litre were employed as stabilizers in the bleaching liquors. Bleaching was started in cold and slowly raised to 60° C. in two hours' time; rinsed, soured with 1% hydrochloric acid, rinsed, etc.

TABLE II

		Calcium Hypochlorite Perchloron					*Sodium Hypochlorite*				
	Set Nos.	*Egyptian*	*Uganda*	*American*	*Surat*	*Indian*	*Egyptian*	*Uganda*	*American*	*Surat*	*Indian*
1. Percentage of ash content in bleached samples	I	0.06	0.057	0.055	0.061	0.058	0.054	0.056	0.056	0.055	0.053
	II	0.046	0.045	0.043	0.0437	0.044	0.044	0.044	0.043	0.0421	0.042
2. Percentage of fatty matter in bleached samples	I	0.058	0.055	0.056	0.055	0.057	0.061	0.059	0.059	0.06	0.062
	II	0.023	0.021	0.024	0.022	0.0213	0.02	0.022	0.022	0.0225	0.023
3. "Whiteness values"	I	41.58	41.35	44.8	43.96	42.94	43.97	42.3	41.58	44.00	42.94
	II	43.6	42.3	45.3	43.3	42.6	44.8	45	43.2	42.7	44.2
4. Percentage of "whiteness values"	I	70.68	70.30	76.10	74.73	72.52	74.7	71.9	70.7	74.9	73.00
	II	73.9	71.69	76.95	72.37	74.91	76	76.27	73.22	72.37	74.91

		Hydrogen Peroxide					*Sodium Peroxide*				
	Set Nos.	*Egyptian*	*Uganda*	*American*	*Surat*	*Indian*	*Egyptian*	*Uganda*	*American*	*Surat*	*Indian*
1. Percentage of ash content in bleached samples	I	0.05	0.048	0.05	0.049	0.047	0.052	0.052	0.051	0.052	0.05
	II	0.031	0.03	0.03	0.032	0.029	0.031	0.032	0.0316	0.032	0.03
2. Percentage of fatty matter in bleached samples	I	0.056	0.057	0.055	0.054	0.054	0.052	0.054	0.05	0.052	0.049
	II	0.021	0.023	0.020	0.021	0.021	0.020	0.021	0.023	0.020	0.022
3. "Whiteness values"	I	44.26	39.00	43.1	43 6	42.36	40.77	40.47	40.59	40.7	40.09
	II	44	41	42.2	41.1	39.1	45	44.2	42	42.9	39.5
4. Percentage of "whiteness values"	I	75.24	66.4	73.3	74.22	72.00	69.8	68.8	69.1	69.3	66.6
	II	74.57	69.49	71.52	69.66	66.27	76.27	74.91	71.2	72.71	66.27

The ash contents of the bleached samples were determined by burning the dried samples[4]. And the residual fatty and waxy matters in the bleached samples were estimated by extracting them with ligroin (P. P. 70° C.) in a Soxhlet apparatus[19]. These determinations are set out in Table II.

The extent of whiteness in bleached samples was determined by an Osram Photo-electric cell of K. M. V. type having an uniform response throughout the visible spectrum. The photo-electric current was amplified by two balanced L P 2 Osram valves. The amplified current produced an illumination that was of the order of a few miliamperes and showed itself by large deflections on a mirror galvanometer. The deflections were controlled to required amount by means of a shunt, while the zero of the instrument was kept constant for a period sufficient for the completion of a set of measurements. A wooden framework having a circular aperture of two inches was set permanently at an angle of 45° over the glass window of the box containing the photo-electric cell. On this framework bleached samples (7 c.m. square in dimensions), previously mounted on black cardboards having the threads lying in close parallels to one another, were placed so as to reflect the day light emerging from a large window through the aperture at normal incidence on the photo-electric cell. The measurements were carried out in duplicates in less than fifty minutes (each set) so that during the period the variation in the intensity of day light was negligible to cause error of observation and it could be reckoned as good as an artificial light, for the standard surface gave the same deflection before and after each set of measurements. In order to compare the intensity of light reflected by the bleached samples, a slab of magnesium carbonate was employed as a standard white surface. The measurements of the intensity of light reflected by the bleached samples will be called as "whiteness values" hereafter; and the percentages of the "whiteness values" were deduced from whiteness values of the standard white surface, namely magnesium carbonate, assuming its intensity of reflection to be 100, though actually it was 59 c.m. The results so obtained are set out in Table II.

In Table III, the five varieties of cottons bleached with different bleaching agents are given ranks and are numerically indicated with regard to the extent of whiteness by visual inspection and in respect of the two sets of samples. The ranking merit is in the descending order of whiteness from 1 to 5. Like ranks are given to the five varieties of cottons based upon the values of residual ash content, fatty matter content and "whiteness values" symbolically expressed as "A," "F" and "W" respectively. These ranks are attached to the ranking by visual inspection only when they are found to coincide. (Refer to Table III.)

CONCLUSIONS

1. From Table III, it will be seen that the whiteness determinations by the photo-electric cell method agree well with the visual in as many as 32 cases out of 40. Hence it is proved that the photo-electric cell method serves as a reliable index for the measurement of the degree of whiteness found in bleached materials.

2. It will be remembered that sets No. 1 and No. 2 were subjected to different scouring treatments followed by identical bleaching treatments. The results of these differential scouring treatments are, however, very far reaching. From the visual indications it is shown that for Set No. 1, Hydrogen peroxide, Sodium peroxide, Sodium

(Continued on page 820)

PROCEEDINGS OF THE
American Association of Textile Chemists and Colorists

DECEMBER 13, 1937

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REPORT FROM NORTH CAROLINA STATE COLLEGE STUDENT SECTION

THE Section has had as guest speakers so far this term, the following men:

Mr. J. R. Hill, '36, with Proximity Print Works, Greensboro, N. C., who spoke on the problems in printing.

Mr. Thomas Blackwoods, also with Proximity Print Works spoke on continuous vat dyeing.

Mr. J. W. Ogletree, '37, who is with Southern Bleachery and Print Works, Taylor, S. C., gave a talk on mixing and handling of colors in the print works.

Mr. Robert Murdock, '36, who is with National Aniline and Chemical Company talked on some of the problems of dyeing.

Mr. J. H. Byrd, '26, who is chemist in the dyeing and finishing plant of Marshall Field and Company, Spray, N. C., spoke about the chemist in the dyeplant and what he is expected to do.

Mr. G. R. Bellamy, '36, from the Charlotte office of Ciba Company spent two days in the school. Mr. Bellamy demonstrated various products and talked on money value of dyestuffs, and procedure in the laboratory.

We have been on an inspection trip to the dyeplant of Pilot Mills. Mr. Paul Hughes, foreman of dyeing, showed us through the dyehouse and explained the way their work is handled.

The chapter wishes to express its appreciation for the time these men have given us.

Respectfully submitted,

J. A. HOLDER, *Secretary.*

Seventeenth Annual Meeting

Philadelphia Welcomes the A. A. T. C. C.

Photos by John J. Sokolinski

ONE of the most successful meetings in the history of the Association, both in point of attendance and quality of program, was held in Philadelphia, Pa., on December 3rd and 4th, under the auspices of the Philadelphia Section. The various committees spared no effort to insure that the visit of each member and guest would result in a thoroughly profitable and enjoyable occasion. A great many were on hand early Friday and registration continued at a rapid pace throughout the day as well as on Saturday. During the afternoon many visitors on their first trip to Philadelphia, as well as others, took advantage of the sight-seeing tour, which had been arranged, to the Franklin Institute and the Planetarium. The Ballroom of the Bellevue-Stratford was filled to capacity for the Platter Supper on Friday evening following which the convention was officially opened and the visitors welcomed. Following the presentation of a paper and a motion picture a varied and well received program of entertainment was presented to an appreciative audience. Saturday was taken up with the presentation of the technical papers which had been arranged by the Technical Program Committee. The Annual Banquet was held on Saturday evening with Elvin H. Killheffer, Past President of the Association, acting as toastmaster. Following the banquet, dancing was enjoyed.

In view of the success of the meeting the thanks and appreciation of the Association is due to the various committees, the personnel of which follows: General Chairman, Elmer C. Bertolet; Vice-Chairman, Alban Eavenson; Treasurer, William A. Stringfellow; Secretary, Richard M. Ritter; Technical Program, Carl Z. Draves, Chairman; Banquet Committee, Arthur W. Etchells, Chairman, Boyce C. Bond, James P. Conaway and William A. Stringfellow; Entertainment Committee, Arthur E. Jones, Jr., Chairman, A. Winston Edwards, Daniel McGowan, Jr., and Fred Scholler; Publicity and Sightseeing Committee, Charles A. Seibert, Chairman, Walter G. Hamlen, Jr., and Paul L. Speakman; Reception Committee, Walter F. Fancourt, Jr., Chairman, William H. Bertolet, Jr., Ernest C. T. Bick, James A. Branegan, Harry Buckley, William G. Diamond, William Ebersold, G. S. Hiers, John A. Levering, John McCoy, Henry E. Millson, Robert M. Moore, Joseph Schmitz, Jr., H. G. Smolens and Herbert S. Travis; Registration and Registration Committee, George E. Kohn, Chairman, Robert O. Beadel, Robert W. Delaney and Harold B. Dohner, Secretary. All in all, the Philadelphia Section and the City of Philadelphia as well prepared a real welcome to those in attendance.

Very excellent arrangements had been made for the entertainment of visiting ladies during the presentation of the technical portion of the meeting. Souvenirs were presented to all of the ladies and numerous prizes awarded for bridge.

A complete stenographic report of all papers presented, addresses delivered and discussions will appear in future issues of the REPORTER.

The WHAT of Textile Technology*

E. R. SCHWARZ, F.T.I.†

THERE are three words which I believe should appear on the walls of every laboratory in large letters. They are WHAT, HOW and WHY. They sum up the essence of research. The order in which I have listed them is not accident—first must come the fact finding, then the relationships between the facts and finally the interpretation and the reason for their existence. Without the basis of solid fact no scientfic investigation is possible, hence I make no apology for taking the first word of the series—WHAT—as the subject for discussion. And I am going to consider it both as a question and as an affirmation.

As a question it may concern superficial observation or critical observation. Superficial observations are all too easy to make and all too often made. The only excuse is lack of experience and vision on the part of the observer. For example textile fabrics have been tested in tension for years, and the tensile test by either the strip or the grab method is standard all over the world. The superficial observer is quite content to watch the strip of fabric break in the machine and is perfectly satisfied to record the strength as so many pounds 'tensile.' True enough, the initial application of force to the sample is a pull, and hence the word tension applies for an infinitesimal time after the machine is started. But no sooner is the load felt by the material than a very complex chain of events is initiated. Yarns straighten, bend, rotate, press against each other. Fibers slip, stretch, twist and bend. Eventually the fabric pulls apart—so says the superficial observer. But does it? No, not until some yarns and fibers have been compressed, some have sheared,—some have stretched—all have been subjected to rapidly varying forces from constantly changing directions, and each force modifying the action of the next. The specimen may have been subjected to a pull, but it breaks because of combined tension, torsion, shear and bending. Not at all a simple state of affairs and one that even yet baffles the textile technologist. Is it any wonder that the tensile strengths of two specimens containing the same set of yarns and prepared and conditioned in the same way, when tested in immediate succession will differ from each other in strength? Rather the wonder is that the difference is not greater.

The critical observer sees in the simple tension test a multitude of chances for additional investigation, and for splendid opportunity to find out what really happens. Immediately he lists the phenomena which he has isolated, he finds the necessity of clearly separating and defining them brought home intensively. He cannot study shearing action due to torsion, while bending compression and tension complicate the matter. He must at once devise tests which make possible the isolation of each phenomenon for independent study before he can hope to investigate them collectively. Hence the need for a means of measuring the torsional rigidity of fibres and yarns. If he would isolate the bending effects, he must experiment with means for producing repeated flexing of the sample. Compressional resilience must be studied, and when he is satisfied that he knows what is happening, he may attempt to correlate his findings in order to discover how they act in combination. If this is solved the next problem is why they act as they do, and this consideration opens up the entire field of the ultimate structure of the fibres.

It is obvious that no investigator of however great ability can hope to progress in the isolation and study of phenomena, unless he has first defined his terms, has built up a definite understanding of the real meaning of the words which he uses. How often we find in the literature the phrase—'The yarn failed under a fifty ounce strain' or 'The elasticity of this yarn was 16 per cent.' Remarkable yarns these. As remarkable as the boy who could run at the astounding speed of fifteen bushels an hour, or the man who descended into a mine a distance of five tons. Absurd, you say! Certainly. But no stranger than strain expressed in units of force instead of distance or per cent. No stranger than the confusion of plasticity, elasticity, extension and elongation. We have words for things like the Greeks. Let's use them correctly. Sloppy use of terminology is the sign of sloppy thinking. Such thinking cannot be tolerated in connection with research. We must not only know what happens, but what to call each happening.

To return to stretch as a case in point—we may have positive stretch or negative stretch, that is extension or contraction. We may have completely and instantly recoverable stretch upon removal of the stretching load—that is elasticity. We may have stretch occurring in such fashion as to be dependent upon time—that is plasticity.

† Professor of Textile Engineering. In charge: Textile Research, Mass. Inst. of Technology.

* Presented before meeting, N. N. England Section, November 5, 1937.

We may have non-recoverable stretch, that is elongation. To say, therefore, that a textile material stretches is like saying that you have just seen a person. Was it a man, woman, boy, girl, blond, brunette, French, Negro, alive or dead? No one knows unless you use the exact word descriptive of what you really saw. I had the dubious pleasure a short time ago of reading a paper on textile testing which included a discussion of certain curves drawn to show the relationship between extension and load for certain rayon fibres. It was stated that at a certain point in the curve where the slope of the line changed somewhat, there was 'the elastic limit or yield point.' That is much the same as saying that at the corner of Tremont and Boylston Streets in Boston is the Little Building or dog pound. There is equal similarity between these two as between elastic limit and yield point. While it is conceivable that under very peculiar circumstances the Little Building might actually serve the city of Boston as the dog pound, it is not likely to be a frequent occurrence. Equally true is it that the likelihood of the elastic limit being also the yield point is remote. They may be close together—and the Little Building is not too far from the Animal Rescue League Headquarters, but they are definitely not in the same building, or even on the same street. The elastic limit is the end point of that portion of the stress-strain curve where a direct relation exists between stress and strain in the form of a constant ratio. The yield point on the contrary is that point in the curve where extension commences and continues without a change in load. Many rayon filaments and yarns show a definite elastic limit—but almost without exception they fail to show a well defined yield point. Nor is such use of terms a picayunish splitting of hairs. It is very necessary if the research worker is not only to mean what he says but say what he means. A scientific statement which is open to several interpretations simply because of loose wording is inexcusable. Nor is the maze of legal verbiage which seems to be the rule in certain quarters essential. To be correct and clear a statement need not be verbose. If brevity is the soul of wit—so too is it the soul of scientific writing.

The observation—critical observation—of actions and reactions quickly becomes a study of variable factors. Many such exist in textile testing. To continue the example of tensile testing we might note the effect upon strength of the manner of preparation of the sample, the location of the sample in the original fabric, the separation of the testing machine jaws, the speed of operation of the machine, the constancy of the speed of operation, the capacity of the machine and the manner and the degree of stretching of the specimen, not to mention the moisture regain of the sample and the nature and duration of the conditioning prior to and during testing. There are also difficulties due to the fact that the machine may be not in perfect calibration, that the operator may not be consistent in the tightness with which he screws up the jaws, or in the angle of placement of the specimen. He may look up at or down at the dial instead of straight at it. He may read first one side of the pointer and then the other. He may make a poor estimate of fractions of a scale division. There may be unsuspected friction in the testing machine. The chain joining the jaw to the loading drum may be slightly out of place. The zero setting of the pointer on the dial may be faulty. All of these are errors—instrumental, theoretical or personal. But all are controllable or subject to correction or elimination. Even after they have all been considered and proper means taken to account for them, there still remain a host of other variable factors which go unsuspected and which cannot be taken into account. These produce residual errors. Fortunately they follow a law which can be worked out mathematically. Paradoxically it is called the Law of Chance. Given a sufficient number of observations all influenced by these residual errors, we find that the variations which they cause from the best obtainable value of the desired reading fall in a curve of characteristic shape—known as a frequency distribution. By proper means of obtaining and handling the data for a test it is possible to make the variation from the best obtainable value so slight as to be negligible. Frequency arrays are also met with in textile testing practice in connection with the observations themselves. If for example, several hundred wool fibres are measured for diameter, the diameters can be arranged in a frequency array. That is the frequency with which a certain diameter occurs will be great, while the further the departure of the diameter reading from this value, the less frequently it is found to occur. The shape of the frequency distribution curve for each quality of wool allows of the identification of a given batch of fibres as being of a certain quality. On this basis the standards for the determination of the quality of worsted top are now being set up.

I have used the term — Best obtainable value — frequently and since the true value of a measurement on textile materials is seldom known or obtainable this is all that one may hope for. Nobody knows what the true tensile strength of a piece of cloth is. But if we achieve better and better control and understanding of the test and the factors which influence it we can more and more closely approach the unknown true value. The result which we obtain after all possible errors have been accounted for as an average of a suitable number of tests is the best obtainable value and can be made to differ only very slightly from the true value which remains still unknown.

I do not intend this to be a dissertation on precision of measurements, but since the word 'precision' has arisen, we had better define it. Perhaps no term is so frequently relegated to the scrap heap in favor of a wrong word than is this one. We hear a lot about the accuracy of the work done by the modern textile technologist. Accuracy in connection with textile testing of whatever sort is almost

never obtainable in any degree. This is because the accuracy of a reading is its nearness of approach to the true reading. The difficulty of obtaining a true reading is apparent if we simply examine the difficulty in measuring the width of a piece of cloth. In the first place the measuring rod which you must use is not exactly one yard long. Only the primary standard yard at the Bureau of Standards is one yard long. Your yardstick may approach this true value closely and therefore be satisfactorily accurate, but the measurement which you hope to make with it can never be accurate at all. In order to apply the yardstick conveniently to the fabric the cloth must be laid flat on a flat surface. It must be laid flat but not stretched; how do you do this? The end of the yardstick must be placed exactly at the edge of the fabric. At what point along the fabric shall this be done? Will the width of the cloth be exactly the same at every fraction of an inch along its length? You know it will not. Then which inch shall you select as the place to start your measurement? Which place in the fabric represents the exact width? Can you ever be sure that the end of the yardstick is exactly coincident with the edge of the fabric? What constitutes the edge, and how far must you move in either direction from your starting point to define the direction which the edge takes? Further, you must measure from something to something. Is the other edge of the cloth any more definitely locatable than the one from which you started? Is it exactly parallel with the first edge? Can you lay your yardstick so that it will be at right angles to both edges at once? How close can you measure a right angle anyway? and then how close can you read your yardstick—an inch, a quarter inch, a hundreth? And so on far into the night. Yet we measure the width of fabrics every day in the week. But no matter how many measurements we make, and no matter how closely the intervals are spaced at which we make the measurements we can never find the true width. We only get the best value obtainable under the circumstances. We get a value that approaches the width of the fabric after all known errors have been accounted for. We approach the width with a certain degree of precision—but never with accuracy.

And so it is with most textile determinations. Some determinations can be made with accuracy, however. For instance, if a certain rayon yarn is made with 100 filaments and the average of a series of counts gives us 98, we are 98 per cent accurate. Here 100 is the true value. If we do not know what the true value should be, however, then we are correct to a certain degree of precision which can be determined statistically from study of the deviations of individual counts from the average. Nor is this discussion to become a lecture on statistics. It is enough to point out forcefully that no textile technologist can consider his training complete unless he has achieved a reasonable facility with the statistical method of handling data. Far too much experimental work of value has gone to waste or been misinterpreted by reason of lack of knowledge of how properly to treat the data.

From statistical methods to interpretation of data, then, is a short step indeed. We all recognize the power of the printed word. Because a statement is in print far too many of us consider that it must therefore be true and infallible. Similarly because certain data when plotted give a smooth curve we are too prone to infer that there must be a cause and effect relationship involved.

For example the curve before you shows the average monthly temperatures from January to August over a period of years extending from 1873 to 1933 in the city of New York plotted against the breaking strengths of certain cotton yarns testing in England in 1927. The result is a straight line and would seem to show to those who believe blindly in the virtues of a plot that the increase of temperature in New York from winter to fall over a period of 60 years causes the strength of cotton yarn tested in England in 1927 to increase. It is of course obvious that there can be no relationship between the two sets of data. A plotted curve can be studied effectively only when from other considerations a relationship between the variables is suspected or certain.

Upon further consideration it will also be apparent that for a plot to show the relationship between two quantities which are simultaneously varying no other causes of variation in either factor can be present. This means in carrying out the test to obtain the data in question, all factors which could influence either quantity of the plot must have been fully accounted for by process of correction or elimination. Unless this is known to be true the plot must be treated with caution.

And there are plots and plots. Sometimes the value against which the data is plotted is known not to be a cause of change in the value of the data. A simple case is the plot of strengths of several grab test specimens from a piece of cloth. The strength in pounds is plotted vertically, and the number of each sample is shown horizontally. This is done in order to separate each reading from its neighbor. It also shows among other things how far removed each reading is from the average and whether it is above or below that value. To show that the maker of the chart realizes perfectly that changes in strength in the cloth do not depend upon whether the sample is number 2 or number 7, a block diagram is made. Had the points been connected by a series of straight lines it would have indicated much the same thing in another way.

To put a smooth curve (the one best representing the points) through the data would indicate at once that the maker of the plot felt that there was a cause and effect relationship between the data plotted vertically and that plotted horizontally. Such curves should only be used when it is certain that a mathematical equation can be written which will show how one quantity varies with the other.

There is not time, nor is this the place to enter into the details of how equations may be fitted to curves. It is sufficient to say that many formulas are derived that way. A number of tests or readings are made as a part of a carefully planned experiment, calculated to show what sort of relationship exists between the factors under investigation. This is simply the determination of a series of *whats,* which can legitimately be plotted to show *what* the experiment really shows. Then in order to avoid troublesome and constant reference to a chart, the equation which fits the empirical curve is found. This is then used as a formula into which data may be substituted. In some cases, the formula may, in turn, be converted into a chart—this time an alignment or nomographic chart which makes computations unnecessary. Simply by indicating or drawing several lines across the chart so that they connect the known values, the answer may be read directly. An example is a chart devised by the speaker to represent the formula used to correct the strength of cotton fabrics to that at any desired regain. The formula itself results from the study of thousands of specimen strengths determined in the M.I.T. textile laboratory at various conditions of atmospheric humidity and temperature. The data from the tests were plotted in a series or family of curves, and the equation representing that family of curves was found. This is the formula appearing finally as a nomograph.

So much for statistics and plotting. Even in computation of results *what* you get may be misleading unless the precision of the figures is taken into account. It is widely and wrongly believed that the more decimal places that are carried in making a calculation, the more precise the calculation is. This can easily be disproved by reference to the sample computation outlined:

Suppose that an overseer measures the diameter of the leather covered front roll of a spinning frame with a pair of calipers, and finds that he gets a value of 7/8". This, expressed in decimals, from the usual conversion table or chart is 0.875 inch. It is possible perhaps that this overseer remembers the value of π to five decimal places. (3.14159) Thus he computes the circumference of the roll as

$$\begin{array}{r} 3.14159 \\ .875 \\ \hline 1570795 \\ 2199113 \\ 2513272 \\ \hline 2.74889125 \end{array}$$

This is computed to the nearest hundred millionth of an inch or about 1/100th of the wave length of the shortest wave length of the shortest x-rays used for fibre atomic structure analysis. Absurd!

Since we only know the value of π to five places we should really indicate the sixth place by means of an 'x'. And similarly the fourth place is uncertain in the other figure. Placing an 'x' for this place and then multiplying we get—

$$2.7\text{xxxxxxx}$$

In other words the only figures we know are 2 and 7. We are only justified in measuring to the nearest tenth of an inch at the most. We could have obtained the same answer and saved ourselves a lot of time and trouble by multiplying thus—

$$\begin{array}{r} 3.1 \\ .9 \\ \hline 2.79 \end{array}$$

Referring to the original computation, we see that the figure correct to two places was 2.75 or 2.8 correct to one place. The answer agrees with that obtained from the shorter calculation.

Thus precision is not a matter of the number of decimal places you can get in the answer, but is governed by the number of places in the least precise figure. Certainly we could not measure a soft leather-covered roll with steel calipers to closer than a tenth of an inch, hence 0.9 inch is all we can possibly write. Hence 3.1 is all that we can legitimately use of the value of π.

The value of research lies in what you measure and in what you do with the measurements. Ask yourself first, What am I measuring? Second, What units am I measuring it in? Third, What is the precision of my measurements? And finally, What do the results mean? In a word the WHAT of textile technology.

MEETING, PHILADELPHIA TEXTILE SCHOOL STUDENT SECTION

A REGULAR meeting of the Philadelphia Textile School Section was held on Friday, October 22, with Chairman Wayne Fry presiding.

Mr. Doc Eddington, who worked during the summer with Sidney Blumenthal Corporation, gave a talk on the general workings of the plant.

Mr. Walker who was with the Ciba Dyestuff Corporation during the summer talked on "Ninety days in the Control Lab."

Both talks were very instructive and gave the members an accurate picture of life in the industrial world.

A question was put to the class, to be settled later, as to whether they would like more speakers from the class or an outside speaker.

Respectfully submitted,

ROBERT F. ROECKER.

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F. H. Winter—Student, Philadelphia Textile School, Philadelphia, Pa. Sponsor: E. Bertolet.

ANNUAL MEETING, PIEDMONT SECTION

THE Annual Meeting of the Piedmont Section was held at the Carolina Hotel, Pinehurst, N. C., Saturday, November 6, 1937. About sixty entered the golf tournament Saturday morning and the following successful entrants were presented with prizes at the banquet Saturday evening:

Low net.....R. E. Summers
Second low net.....Peter Gilchrist
Third low net.....T. C. Van Loan
High net.....J. P. Bauer
Low gross.....Vernon Vaughan
High gross.....Magee Calhoun

Two papers were presented at the technical session Saturday afternoon: "The Dyeing and Finishing of Spun Rayon Fabrics" by Ross M. Stribling of the American Enka Company and "The Causes and Correction of Some Typical Hosiery Defects" by Dr. H. H. Mosher of the Onyx Oil and Chemical Company. Both of these papers were followed by considerable discussion. Mr. Hintze of the Rock Hill Printing and Finishing Company led the discussion following Mr. Stribling's paper and Mr. H. Grady Miller of the Elliott Knitting Mills led that following Dr. Mosher's. About one hundred and twenty-five members and guests attended.

The banquet was held at 8 P. M. Saturday evening with about two hundred and forty attending. Dr. Harold D. W. Smith of A. M. Tenney Associates addressed the gathering on "The Properties That Effect the Dyeing of Acetate." Following Dr. Smith's paper motions were presented instructing the secretary to send wires of sympathy to Mr. Paul Haddock, who is seriously ill and Mr. G. S. McCarty, who has recently suffered a death in his family. It was also voted to send flowers to Mr. Haddock. On motion of Mr. Charles Stone the members stood in silence in memory of Mr. Webb Hunt of Greensboro who recently died. The reports of the secretary and treasurer were presented. Mr. Arthur Jones of Philadelphia presented a short address concerning the coming Annual Convention in Philadelphia and urged the members of the Section to attend.

Mr. T. R. Smith, chairman of the Section, made the following recommendation: "At a meeting of the Sectional Committee and the present officers of the Piedmont Section, held this afternoon, it was recommended that the incoming chairman appoint a committee of six to draw up a set of by-laws to govern the business and meetings of the Section. These by-laws to be submitted to the members for approval and adoption."

The report of the Nominating Committee was then submitted by its chairman, Mr. Wyss L. Barker and the following members were elected by acclamation for the coming year:

Chairman—Dr. Raphael E. Rupp, Pacific Mills, Lyman, S. C.

Vice-Chairman — Mr. Edgar Ford, Sayles-Baltimore Bleachery, Baltimore, N. C.

Secretary — Mr. J. W. Ivey, Mathieson Alkali Works, Charlotte, N. C.

Treasurer—Mr. H. Grady Miller, Elliott Knitting Mills, Hickory, N. C.

Sectional Committee:

Mr. R. H. Souther, Greensboro, N. C.
Mr. T. W. Church, Jr., Charlotte, N. C.
Mr. R. D. Sloan, Greenville, S. C.
Mr. H. O. Pierce, Charlotte, N. C.

Councilor—Mr. Thomas R. Smith, Albermarle, N. C.

Member National Nominating Committee—Mr. A. Henry Gaede, Charlotte, N. C.

Following a vote of thanks to the Nominating Committee and the retiring officers the meeting adjourned.

Respectfully submitted,

A. HENRY GAEDE, *Secretary*.

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SEVENTEENTH ANNUAL MEETING

THE large attendance at the Annual Meeting of the A.A.T.C.C. assured the success of the meeting and is the best tribute to the efforts of the committees that we can think of and their remains little that we can say. The increasingly large attendance at the yearly gatherings is a relative indication of the increasing size of the Association and of its increasing importance. Its members are representative of every branch of textile research and textile wet processing. Another milestone on the road of progress which this Association follows has been passed. It is our sincere wish that it will continue to enjoy the success which it so justly deserves.

STANDARDIZATION

ACCORDING to the American Standards Association there are indications of a widespread trend for the voluntary development of standards by manufacturing industries in the consumer goods field. After a check among trade associations it was found that, out of 53 associations volunteering information, 35 were found to be carrying on programs of standardization as a regular part of their activities. Included in the check were manufacturers of many staples such as cottons, woolens, soap, glassware, shoe laces, underwear, lead pencils, school supplies, upholstery and draperies, wall paper, gas and electrical appliances, lace, stockings, furniture, etc. Three associations maintain special testing laboratories and issue seals of approval for certain manufactured products in their field.

It was also reported that almost all of the 53 associations replying expressed a definite desire to keep in touch with standardization activities of other groups.

In the textile field the ASA reports the following standardization projects:

The National Association of Wool Manufacturers has assisted in the development of a commercial standard for wool and part-wool blankets. It has cooperated in the development of a commercial standard for the testing and reporting of woven dress fabrics. It has also been working on regulations for the labeling of knitted wear and woven fabrics containing special fibers such as camel's hair.

The National Federation of Textiles has provided for the addition of a standards director to its staff. The Federation is also reported as having developed an improved grading of silk, set up standards for testing silk, is carrying on research in problems of wear and has, in an effort to develop standards of nomenclature, launched a campaign to protect the word "silk" from misuse.

The Association of Cotton Textile Merchants has secured general marked adoption of its Standard Cotton Textile Salesnote. It has also furthered the adoption of standard widths and lengths for sheets and pillow cases.

The National Association of Dyers and Cleaners has established a textile approval service for manufacturers of fabrics, which is operating according to the standards of rating drawn up by its research department.

The Laundryowners National Association has set up standards for garment washing through its "laundry tested and approved" program.

The hosiery manufacturers, in addition to the commercial standard for sizes of all types of hosiery, have set up a standardization committee on ladies' full fashioned hose. Their research staff is engaged in developing standard methods of testing silk and hosiery.

Although there is considerable variety in the standardization programs of the associations the ASA reports that almost every project falls into one of the five following classes: (1) standardization of sizes and capacities; (2) performance standards—for strength, wearability, fastness, etc.—necessitating the development of standard methods of test; (3) standards for grading and labeling and nomenclature; (4) construction specifications; (5) standards for finishing and trimming. Practically all of these efforts are directed toward better fit, better wear, or the customer's convenience in replacement or in making additional purchases. It becomes readily apparent that there is a definite trend toward adoption of standards for all industry.

The Next Quarterly Research Number Will Appear January 10, 1938

Economy in

Process Steam Heating

Application of a New Device

C. H. S. TUPHOLME

IN many steam processes heating systems steam is introduced at boiler pressure and temperature at one point, and discharged at various points through steam traps when it has parted with sufficient heat to condense to water. The temperature at which the steam condenses is determined by the pressure in the system, the higher the pressure the higher the temperature at which the change to water takes place.

Owing to the importance of economy in the use of steam in bleacheries, dyehouses and finishing plants, this article should prove of interest to those of our readers who are of an engineering turn of mind.

The discharge of heat from a given area of a system to its surroundings is determined by three factors: (1) The difference between the temperature of the heating medium (steam) in the system and the temperature of the external surroundings by which heat is being absorbed. (2) The conductivity of the material through which the heat has to be transmitted. (3) The rate of diffusion or movement of (a) the air or fluid receiving the heat and (b) the steam from which the heat is being extracted.

Since the temperature of saturated steam increases with increasing pressure it is advantageous to generate steam under a pressure greater than atmospheric, in order to give the necessary heat gradient indicated in (1). Factor (2) is a function of the material used, which is determined by strength and constructional considerations. Regarding factor (3), the diffusion exterior to the heating system is governed by the conditions and purpose of the system; but the internal diffusion in the heating medium is determined by the nature of the heating system, and may be considered as a separate factor.

Steam introduced into the heating system normally exists at boiler pressure. As its heat is extracted by transmission through the walls of the system the steam reduces in bulk by condensation, and by thus lowering the pressure in the system it allows further steam to enter, the amount being naturally proportionate to the amount which is condensed and discharged as water through the steam traps. Movement of the steam in the system is thus caused, first by steam on the walls of the system condensing and allowing further steam from the interior to take its place, and second by fresh steam being allowed to enter by reason of the falling pressure.

These movements are naturally slow and governed entirely by the rate of heat transmission through the walls of the system. Further, the condensation of steam on the walls interposes an inert medium, cooler than the steam, between it and the walls and lowers the rate of heat transmission through them.

Since the movement of steam through the system is not circulatory, but merely one of direct travel due to falling pressure, it follows that the hottest steam will always be at the point of entry into the system, the more distant points being the cooler and consequently less capable of transmitting heat. In order to increase the heat transmission at those more distant points it is frequently necessary to allow steam as well as condensate to discharge from the steam traps, and so stimulate the flow of live steam through the system. This results in unnecessary temperature at the point of steam entry and the wasteful discharge of steam which has performed no useful work.

A continuous circulation of the steam through the system removes the inequalities of heat transmission at different points by stimulating the diffusion of heat in the system. A positive circulation, moreover, aids materially in removing the inert condensate from the walls of the system, and thus allows the necessary intimate contact with the higher-temperature steam.

There are various causes of heat loss in an ordinary system, particularly where a minimum heating duty is required from all parts of the system. These losses include:—

(1) Live steam discharged to waste in order to stimulate flow of steam to the more distant parts of the system.

(2) Unnecessary heat transmitted by the parts of the system nearest to the steam inlet.

(3) Heat in the condensate, which is proportional to the pressure in the system.

Heat loss from the first cause can be prevented by introducing some means of creating a flow of steam through the system. Over-heating of one portion can be prevented by circulating the steam positively, so that the heat is distributed uniformly throughout the system.

The loss of heat in the condensate is unavoidable, un-

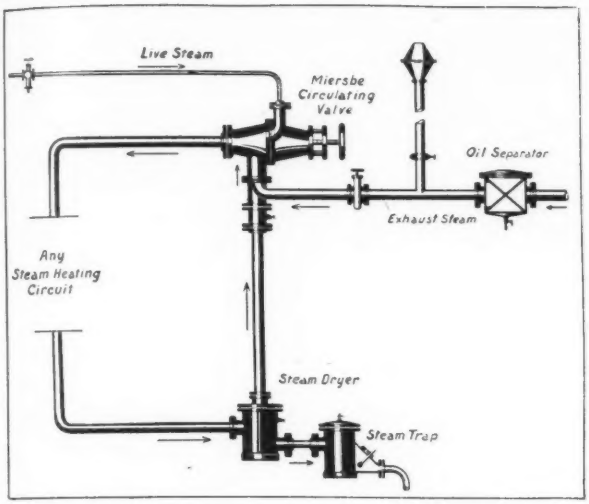

Diagram of Apparatus Utilizing Exhaust Steam, with Live Steam for Circulating Purposes Only.

less the pressure at which it is discharged can be lowered or the condensate returned to the boiler at the same pressure as that of the heating system. This latter is often not practicable and the condensate has to be reduced on discharge to atmospheric pressure, with the result that considerable quantities flash to steam and are lost.

The value of lowering the pressure of the condensate will be understood readily when it is recalled that saturated steam at 100 lb. per square inch pressure (abs.) contains 1,186 B.t.u. per lb., and of this amount 298 B.t.u. are retained in the water when the steam condenses. Steam at 25 lb. pressure (abs.) on the other hand, contains 1,160 B.t.u., of which only 208 B.t.u. are retained when it condenses. Since steam condensing to water at atmospheric pressure contains only 180 B.t.u. per lb., when the higher-pressure condensate is discharged to atmosphere, 118 B.t.u. per lb. are released, to be absorbed by a part of the condensate flashing into steam at atmospheric pressure and becoming lost. When discharged at 25 lb. pressure, the loss in reducing to atmospheric pressure is only 28 B.t.u., which represents a saving of 90 B.t.u. per lb of steam.

In a system recently introduced into some British plants the majority of the steam traps normally required are dispensed with and instead are installed a steam-circulating valve by which the admission of the live make-up steam is controlled, a steam separator and one steam trap for discharging the condensate. These are connected so as to convert the heating system into a complete circuit in which a positive and rapid circulation of steam is induced, not by discharge through the steam trap, but by the special method of introducing the live steam through the steam-circulating valve.

This steam-circulating valve operates on the injector principle, delivering fresh steam to the circuit and inducing a flow of steam behind it. It maintains a positive circulation throughout the whole system at all settings of the valve, whether just open or at full flow. All condensed steam is carried to the separator, which removes the water and delivers the dry steam back through the induction ports of the circulating valve.

The induced circulation of the steam, incidentally, slightly lowers the pressure on the condensed water, which passes to the steam trap at less than the pressure at which it originally condenses. The loss of heat by flashing back to steam at atmospheric pressure is accordingly less. Preferably the condensate is led back to the hot-well for return to the boiler, thus conserving its heat.

The steam-circulating valve is adjustable for any requirements of steam make-up in the circuit, according to the rate of heat transmission and consequent condensation, and a special feature is that at very low rates of steam delivery a positive circulation is still maintained, owing to the special construction of the steam-circulating valve.

The result is that at any rate of heat transmission from the circuit the heating is uniform throughout and no steam is discharged through the steam trap. There is no accumulation of water at any point except the separator and steam trap, and consequently the risk of water hammer and similar troubles due to accumulations of water are obviated.

The rapid circulation of the steam throughout the circuit ensures very rapid heating to the desired temperature. In the case of industrial plants utilizing this heat, such as dryers, boilers and heating coils of every description, this feature considerably increases the output of the plant. Also, a higher and uniform temperature can be obtained without increasing the steam pressure. Exact adjustment and regulation of temperature and pressure is possible in every case.

In many cases it is to operate the steam-circulating valve so as materially to reduce the pressure of the steam as it enters the heating circuit, while still maintaining a positive circulation. This has the advantage of lowering the circuit pressure and hence the temperature of the condensate, with consequent reduction of the heat lost in the condensate. This feature is of special importance when the condensate is discharged to waste or reduced to atmospheric pressure before being returned to the boiler.

When this system is applied to a heating circuit utilizing exhaust steam, the steam-circulating valve is supplied with a small amount of live steam to maintain the circulation and induce the inflow of exhaust steam. The amount of live steam, of course, can be increased if required to make up any deficiency in the exhaust steam available.

Not only does the system secure more effective use of the exhaust steam, but the back pressure on the machine discharging the exhaust steam is reduced, as it discharges to the induction side of the steam-circulating valve and not against the full pressure of the heating system. The efficiency of the machine is thus improved, less steam being

required for a given output. In addition the rate of circulation in the heating system is increased, the heat transmission made uniform throughout, and increased temperature made possible. The condensate from the steam can be cleaned and made available for return to the boiler as hot feed water.

Creases in Dyed Fabrics*

Their Formation and Prevention

A. J. HALL, B.Sc., F.I.C., F.T.I.

THE creases frequently to be found in dyed and finished textile fabrics can be as interesting to the curious technologist as they are disappointing and objectionable to the dyer who is responsible for them. Yet, although some thousands of pounds worth of fabric must be ruined each year because of the permanent creases formed in dyeing, it is surprising how little attention has hitherto been given to the manner in which creases are formed. Generally, creases are never due to simple permanent folding of the fibers present, although many practical dyers are of this opinion. Creasing is a phenomenon considerably more complicated than this.

Anyone who would understand clearly the manner in which creases are formed in fabrics, both knitted and woven, should carry out one or two experiments with various individual fibers such as those of cotton, rayon, silk, etc. A few individual fibers should be fixed around the edge of a strip of metal so that at the edge each fiber is acutely creased. The metal strip should then be placed in a hot soap liquor such as is frequently used in dyeing, and in this manner the fibers can be maintained in a creased condition, just as they might be during a dyeing process when forming part of a fabric. After withdrawing the fibers from the liquor and releasing them from the metal strip it will be found that they show but little tendency to remain in their creased condition, and certainly after a slight stretch lengthwise all evidence of creasing will be permanently removed. These results will be found applicable to all fibers, and it must be concluded that creases in fabrics cannot be attributed to simple permanent bending of the fibers present.

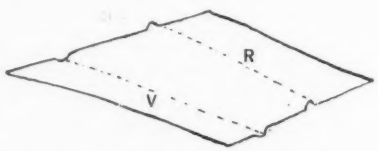

Fig. 1.—Creases in Fabric

One of the most characteristic features of a crease in a dyed fabric is that it can be removed, or at least nearly eliminated, by suitably stretching the fabric either in the warp or the weft, and that as soon as the tension is removed the crease returns with its former prominence. If the fabric is wetted and dried while stretched the crease will seldom return on release of the tension, but if the fabric is again wetted and dried quite slack then the crease reappears. Stretching of the fabric is thus one means for eliminating a crease temporarily.

Another method for making a crease less prominent is that of hot pressing the fabric while it is slightly damp; a high pressure calendering is effective in this manner. But again, the crease will reappear when the fabric is wetted and allowed to dry slack.

These facts are consistent with the view taken of creases in general that they are permanent deformations of the fabric, and this can be confirmed by visual observation of the fabric itself. Careful observation invariably shows that the crease is a "valley" V or "ridge" R across the fabric as shown in Fig. 1. It is thus easy to understand the removal of the crease by stretching the fabric.

Turning now particularly to the manner in which a ridge can be formed, it will be most convenient to refer first to a crepe fabric. A material of this type contains highly twisted yarns which are in an unstable condition and which will revert to a more stable form as soon as they are wetted. If such a piece of fabric is immersed in water the twist threads snarl (this is equivalent to untwisting when the ends of the threads are fixed) so that the fabric contracts in size and becomes thicker. So long as this action is allowed to take place freely the fabric remains perfectly flat and no creases are formed, but if the wetting is allowed to take place while the fabric is maintained in a creased condition then this crease becomes permanent and is seen to be a ridge in the fabric surface. Closer examination of the crease indicates that the ridge is due to a special arrangement of the threads of the fabric immediately around the ridge. The permanent character of the ridge is now easy to understand.

It must be clearly understood that in the wetting of the

*Textile Mercury and Argus.

crepe fabric all the threads move relatively to each other and finally attain positions in which they are stable, that is, positions to which they will always tend to revert even if afterwards temporarily disturbed. Consequently, all the threads in and around the crease (produced by wetting the crepe fabric while in a creased or folded condition) will also be in a stable condition, but their arrangement at the crease is different from the general arrangement at other parts of the fabric for the simple reason that they accommodated themselves to the crease during the wetting. The ridge in the creased fabric is, therefore, not really a temporarily distorted form of the fabric—it is a perfectly stable arrangement of the threads. For this reason the ridge is permanent and cannot be removed except temporarily by stretching or pressing. Always will the fabric tend to return to a condition in which the ridge is present because the arrangement of the threads around this ridge is then most stable.

So far, attention has been directed to a crepe fabric because it is a good example of an unstable fabric which during wet treatment changes to a stable form. The high degree of instability of this type of fabric makes it especially liable to crease formation in the creping process, and it is well known that this process must be carried out while the fabric is maintained in open width and completely free from acute folds of any kind. But the same principles apply to other fabrics and, as might be anticipated from the foregoing considerations, it is possible to have creases formed in fabrics made from silk, which is the most crease-resisting fiber.

PERMANENT CREASING

On the whole, the susceptibility of a fabric to permanent creasing is measured by its tendency to shink in area during the dyeing or other wet processing. The greater the amount of shrinkage the more likely is it to form permanent creases. A fabric which shinks but little can be wet processed in a creased or folded condition with but little risk of becoming permanently creased. Many plain woven fabrics are of this type. But there are several instances of types of fabric which readily become creased and which deserve mention.

One type of fabric which gives the dyer special trouble is acetate rayon Milanese fabric; this is most unfortunate for it is a very high quality type of knitted fabric. The usual manner of processing this fabric is to sew the selvedges together so as to form the fabric into a continuous tube and then scour and dye it in the same winch machine. The dyer who tackles a fabric of this kind for the first time usually receives a rude shock when he sees it finally finished, for it is most likely that he will find it covered with creases or so-called "crowsfeet." Thereafter, he will waste many hours in a vain endeavor to remove these creases and finally come to the conclusion reached by most dyers that prevention is better than cure.

The creases are formed during both the dyeing and the scouring (both operations are carried out in a hot or boiling soap liquor) for in these operations the fabric tends to acquire rope form and in this state there are innumerable folds or creases in the fabric awaiting to be made permanent.

A Milanese fabric is particularly liable to creasing because it is closely knitted and because it suffers a considerable area shrinkage when first wetted. The creases become permanent as they are wetted, especially if the fabric is under considerable stretching while it is drawn around the winch in scouring and dyeing. The only method for avoiding or minimizing such crease formation is that of first wetting the fabric so that it shrinks slowly and while in a very loose condition. For this reason it is advisable to wet the fabric in cold water before scouring so that the fabric can then contract slowly. Under these conditions there is an opportunity for the fabric to shrink in the loosely folded parts without ridge or crease formation.

Silk Milanese fabrics are also very liable to creasing in the same manner as acetate rayon fabrics.

In cotton and rayon woven fabrics the presence of yarn of high twist is usually sufficient to make the fabric creasable. A cotton poplin shirting fabric can be very roughly handled without fear of formation or permanent creases for the simple reason that it does not contract appreciably in area; as a matter of fact in scouring and dyeing the fabric actually increases in area. But a twist yarn always contracts in length on wetting and thus is able to cause area shrinkage in a fabric. Rayon and cotton crepe fabrics which can shrink up to 50 per cent in length or width are obviously very susceptible to creasing and must be processed in open width.

With such highly shrinkable fabrics the formation of permanent creases can be avoided to some extent by control of the rate of shrinkage. If the fabric is kept moving so that the folds in the fabric continually change their position then pronounced creases do not form. But this is only possible by first wetting the fabric in cold liquors, for under these conditions (as distinct from direct immersion of the fabric in a boiling liquor) the position of the fold changes before sufficient shrinkage in area has occurred to necessitate the threads around the fold becoming markedly distorted.

Within recent years pre-embossing of rayon crepe fabrics has been employed, for this tends to induce the fabric to contract along the embossed lines rather than along a crease.

The dyer of rayon fabrics which have been previously creped sometimes encounters creasing difficulties in a curious manner. It would be anticipated that the creping operation would obviate creasing in the dyeing operation which follows for the reason that the fabric is then full shrunk. But it sometimes happens that the fabric is not shrunk to its limits in creping. This may occur because a special crepe appearance is desired and the creping process has been shortened to allow this result to be obtained.

From the various facts enumerated above it will be evident that the dyer has to be most on his guard against formation of permanent creases when the fabric is liable to considerable shrinkage during the dyeing process.

Vanadium in Textile Printing*

VANADIUM belongs to Family A of the elements of Group V and occurs in a number of rare minerals, chief among which are Vanadite, 3 $Pb_3(VO_4)_2$, $PbCl_2$; Pucherite; Bi VO_4; Mottramite (Pb Cu)$_3(VO_4)_2$. 2(PbCu)HO_2. It is also found in certain iron ores in small amounts and from here it finds its way into Bessemer slag, in which it is sometimes found in a concentration of 1.5 per cent.

The credit for the discovery of vanadium lies between two chemists, Del Rio and Sefstrom. In 1801 Del Rio analyzed a certain variety of Swedish iron ore and announced the discovery of a new metal. A short time afterwards a French chemist, Collet-Descotils, contradicted Del Rio and maintained that the so-called new metal was merely impure chromium. In 1930 Sefstrom again discovered the metal in the same, or a similar, ore and named the now definitely established new metal vanadium, after Vanadis, a Scandinavian divinity. In a still later analysis it was proved independently by Wohler that the material actually did contain vanadic, and not chromic, acid. Vanadium in metallic form was first isolated by Roscoe in 1867. The most stable members of the series of salts are the metavanadates and of these ammonium vanadate and vanadium chloride are perhaps the most useful and important.

In O'Neill's "Dictionary of Calico Printing and Dyeing," 1862, the following reference to vanadium occurs: "This metal is said to have some resemblances in its combinations to the compounds of chromium, and hopes are entertained that if ever a plentiful supply of its ore can be obtained, it will be of some use in printing and dyeing."

From this time onwards, chemists, dyers and colorists began to take an active interest in the new substance, as testified by references to it in the technical literature of that period. For instance in Dingler's "Polytechnisches Journal," for March, 1877, page 631, Mr. Rudolph Wagner gives an account of the various reactions of ammonium vanadate upon organic substances, and adds historical notes upon the numerous researches made upon vanadium compounds from the time of Sefstrom to the time that John Lightfoot discovered its use for aniline black.

The credit for the discovery of aniline black rests solely with John Lightfoot and to him also falls the distinction of being the first to recognize the importance of the use of vanadium in the development of aniline black. Lightfoot first discovered aniline black in the year 1860 as a result of experiments he was making on what he called "oil of naphtha," a form of impure aniline. Charles O'Neill relates in his "Practice and Principles of Calico Printing" that he saw pieces of calico printed with the finger in aniline black by Lightfoot in 1861.

It was not, however, until 1863 that Lightfoot patented his discovery, and for a time the difficulties of application by roller were so great that it was thought the use in printing of the greatest dye discovery for years would have to be abandoned. The discovery of precipitated copper sulfide by Lauth in 1864 led to its introduction as an oxygen carrier and the consequent removal of most of the prevalent difficulties in the printing of aniline black.

Lightfoot, meanwhile, was still carrying out experiments with other metals capable of inducing the formation of aniline black, and having obtained a specimen of vanadium he discovered that it was by far the most active in this respect. At first the interest in the discovery was merely academic as the metal was exceedingly rare and scarce, but in 1870 it was first offered for sale in the form of vanadic acid or oxide by The Magnesium Metal Company of Manchester, at three guineas per ounce. Lightfoot having obtained some of the precious substance from this source made experiments and his patent of April 12, 1871, contained the first reference to the use of vanadium for the production of aniline black.

Until 1875, however, the use of vanadium made very little progress, but bulk trials in that year met with a considerable measure of success. One of the great advantages of the use of vanadate was the avoidance of the coppering of the doctor blades by copper salts in the print paste, a fault which gave rise to endless printing troubles. In the first vanadium blacks, metavanadate of sodium or ammonia was used, not vanadium chloride, which was a later improvement. Another great advantage was that the blacks so prepared had no action upon the engraving and by exercising certain precautions it was found possible to keep the thickened mixtures for periods which had previously been impossible.

In this connection, the use of vanadate of lead was suggested by Friedländer, with the object of overcoming the problem of the formation of black in the printing color. In using the soluble salts of vanadium in conjunction with the other chemicals, formation and precipitation of aniline black sometimes took place in the printing mixture. Friedländer's idea was to introduce an insoluble salt and so minimize the risk of such formation. The introduction of metavanadate of lead provided a neat solution to the problem in that this salt while insoluble in the print paste, on being steamed on the fabric became soluble and proceeded to act in the required manner.

At this stage some remarks upon the supposed action of vanadate in the production of aniline black may not be out of place. First of all it should be noted that a very small quantity of vanadium salt is sufficient to bring about the necessary interaction between the chemicals involved. It has been estimated that one part vanadate in 270,000 parts of print paste is sufficient to produce the required

*Dyer and Textile Printer.

result of converting aniline salt into aniline black, providing the necessary quantity of chlorate be present.

M. Witz in "Bull. de la Soc. Ind. de Rouen," V., page 159, put forward a "Hypothesis of the Nature of the Action of Vanadium upon the Chlorates in the Production of Aniline Black." Witz pointed out that vanadium was an agent which promoted the action of the salts upon one another in such a manner that the smallest quantities of the metal were sufficient to prolong such action indefinitely in very large quantities of dye liquor or print paste. He also supposed that the action of the vanadium lay in its very strongly marked properties of alternate oxidation and reduction. This action was found to be so precise that the oxidation of the black could be accelerated or retarded at will by varying the content of vanadium in the form of its salts.

The chief salt in use is vanadium chloride. The salts of the metal are prepared from the mineral mottramite and the fact that ammonium vanadate is insoluble in ammonium chloride is utilized in the preparation of the compounds. The metal is extracted from mottramite by means of hydrochloric acid and the salt obtained evaporated with ammonium chloride, when ammonium metavanadate separates as an impure salt. This salt is then recrystallized, ignited to vanadium pentoxide, V_2O_5, which is finally dissolved in ammonia and again recrystallized. Vanadium chloride may be prepared from ammonium vanadate as follows:—

10 gms. ammonium vanadate.
40 gms. hydrochloric acid 32 deg. Tw.
100 cc. water.
10 cc. glycerine 48 deg. Tw.

reduce at boiling point until a blue coloration indicates the formation of vanadium chloride and dilute the solution to 10 liters.

Vanadium Aniline Black

1 lb. wheat starch boiled with
5 pints water
6 ozs. chlorate of soda are added while the mixture is hot. Cool and add
1¼ lb. aniline salt dissolved in
1 pint water. Bulk to
1 gallon and just before use add
⅝ glass vanadium chloride solution (1:1000).

It will be noticed that the addition of the vanadate is recommended to be made just immediately prior to printing, and also when the color is quite cold. The reason for these precautions is fairly obvious in that the object is to prevent premature oxidation of the black in the print color.

One of the principal difficulties in the use of vanadium black is the fact that the quantity of the reagent is so minute that there is a very real danger of uneven dispersion of it through the mass of the print paste. If this should occur, unlevelness of the blacks will be the result. To prevent this it is the rule to add the vanadate not only immediately before printing, but also prior to straining the print paste for the printing machines. The action of straining has a beneficial effect on the even dispersion of the vanadate after the color has already been thoroughly stirred.

It will have been noticed that the thickening used in the above recipe is starch, but for various reasons it is sometimes the practice to use British gums. In such cases it may be necessary to make considerable modifications in the composition of the print paste. If the darker British gums are used it has been noticed that they have a retarding influence on the oxidation of vanadium blacks. In some cases, it may be necessary to use up to twenty times the usual quantity of vanadate, in addition to a much longer aging period.

The darker qualities of British gums are also the more soluble types and the proportion of dextrin in such gums is high. On the other hand, when using starch thickening, dextrin is entirely absent. Now it is well-known that dextrin has definite reducing properties and therefore in the case of an oxidizing action it has a decided retarding influence. In addition, the amount of solids present in the thickening may have an adverse effect on the permeation of the print color by chemicals, steam, etc. For instance in the recipe given above, the amount of starch used is 1 lb.; in the case of British gums this amount would be trebled or quadrupled according to the type of gum used.

It is obvious therefore that the greater the percentage of starch in the print paste the better will be the results so far as depth of shade is concerned. If better qualities are desired and it is not possible on that account to use a pure starch thickening it will usually be possible to arrive at a compromise, without using an unduly large amount of the required gum.

An important application of vanadate has been discovered since the introduction of the soluble vat colors. These dyes are developed by various processes of oxidation which are similar in principle and action to those employed in the production of aniline black. In the steaming process for solubilized vat dyes, vanadate of ammonium is employed in exactly the same manner as vanadium chloride in the recipe already given for aniline black.

Steaming Recipe for Soluble Vat Dyes

50 gms. soluble vat dyestuff dissolved in
2 pints water and added to
½ gallon neutral starch-tragacanth. Add
¼ pint chlorate of soda 4 lb. per gallon and just before use
⅝ glass ammonium vanadate solution (1 per cent.)
⅝ glass ammonia 25 per cent. Bulk to
1 gallon print paste.

The foregoing recipe is not, of course, suitable for every such dyestuff, but it will serve to illustrate the use of the chemical under discussion. Such colors may be steamed for short or long periods according to requirements. A short steaming period under satisfactory conditions will

bring about the development of the color, while a long treatment up to one to two hours has no detrimental effect. In fact, the opposite is often the case in that colors which have been subjected to long steaming are considerably fuller in shade.

The same precautions have to be observed with regard to dispersion of the vanadate, premature oxidation of the color, thickenings, etc., as have already been pointed out in connection with vanadium aniline black.

When using printing processes which necessitate the exposure of surface films of the print paste to the action of atmospheric oxygen the danger of premature oxidation of the color is greatly increased. For instance, in using the sulfocyanide and vanadate process in block printing the spreading of the print paste upon the block printer's sieve gives opportunity for accelerated oxidation. It is also well-known that the soluble vats are easily developed in a photographic manner by the action of strong sunlight. This fact taken in conjunction with the foregoing remarks make the observance of the required precautions very necessary if good results are to be obtained when using the vanadate processes.

Vanadium chloride solution prepared as already indicated may also be used in the printing of Paramine Brown and Fuscamine Brown. Recipes of the following types are used:

Paramine Brown

4 oz. Paramine lumps dissolved in
1½ pints hot water. Stir into
5 pints starch-tragacanth with
¼ oz. Formosul. Cool and add
4 oz. chlorate of soda dissolved in
½ pint water then add
4 oz. ammonium chloride or nitrate dissolved in
½ pint water, and just before use
1¼ glasses vanadate solution (1:1000). Bulk to
1 gallon print paste.

Fuscamine Brown

5 oz. Fuscamine G (C. I. 875) dissolved in
3 glasses Acetin N and
1½ pints boiling water. Stir into
4 pints starch-tragacanth. Cool and add
5 oz. chlorate of soda dissolved in
¾ pint water
5 oz. ammonium chloride or nitrate dissolved in
¾ pint water and
1 glass vanadate solution (1:1000). Bulk to
1 gallon print paste.

It should be noted, however, that in these cases the use of yellow prussiate of potash gives a more stable printing paste than the foregoing mixtures. Goods printed with the colors given in the recipes may be aged or steamed in the usual manner and afterwards washed-off with the addition of 1 lb. soda ash per 100 gallons wash liquor at 140 deg. F.

TECHNICAL NOTES FROM FOREIGN SOURCES

Origin and Early History of Turkey-Red

Karl Reinking and Satri Atayolu—Mell. Textil-Ber. 18, 382 (1937).—The first part of a very full and interesting paper upon the subjects; well worth reading for those who like to know the historical side of a process still practiced and valued.

Bleaching and Dyeing of Horse-hair and "Hog-silk"

TIBA 15, 237 (1937).—A short article of practical nature upon the working up of these two rather unusual textile fibers. No detailed procedures are given, but clear general statements and recommendations.

Dyestuff Determination with Top-dyed Fibers

J. Lanzer—Monats. f. Textil-Ind. 52, 141 (1937).—The determination of the group to which a simple dyestuff belongs, which has been employed in dyeing a given material, is usually a simple matter; but much more difficult when the dyestuff is one whose chemical characteristics bring it possibly into two different groups; for example, Rhodamine S, which contains a COOH group, or Sirius Blue FFRL, which can be vatted. Other difficulties are presented by dyestuffs which as individuals show a deviation from a general characteristic of the group to which they belong; for example, distinct fastness to chlorine of certain sulfur and direct dyestuffs, which as groups are not at all fast to chlorine; or, perhaps, lack of fastness to chlorine displayed by a particular Indanthrene or Naphthol AS pigment, of groups which are usually quite fast to chlorine. It is undeniable that, in any generally well-characterized group of dyestuffs, there will be found some individuals which will deviate sharply, in some essential point, from the general characteristics of the group taken as a whole.

There exist also certain incidental causes for apparently anomalous response to certain tests. For example, as to the nature of the finish of a certain piece of goods; if in that lot Turkey-red oil has been employed, the swatch is sure to give a test for sulfur, though no sulfur dyestuff be present; or, if the finish contains reducing substances, as glucose, dextrine, etc., a soaping test of the swatch will provide the alkali necessary to act with the reducing substance in the finish, resulting at times in the vatting of a vat dyestuff on the fiber (and in some other cases a phenomenon which is difficult to distinguish from vatting, when it really is not vatting at all). In such cases, the

dyeing would be incorrectly noted as not fast to soaping. It is obviously necessary to remove the finish, if it be present, and completely, as far as possible, before the actual work of study of the dyestuff begins.

Classifications according to tables of colortones are quite worthless. It is impossible to classify a beige in any way; or a brown, which may come under an orange (yellow) or a gray. For practical work, too, it is useless to seek to run down a dyeing of the actual individual itself, since so many dyestuffs are not homogeneous, but mixtures. The author (one of much experience) feels that one should first classify the dyeing as fast or unfast to soaping, and then make separate tests for the different dyestuff groups; and that these must be carried out in a definite sequence, in order to avoid certain pitfalls.

One's investigations are more complicated when it is a question of top-dyed colors. In such a case, any amount of theoretical skill will probably prove valueless; what is needed is wide practical experience in actual dyeing. Top-dyeings are carried out in practice for the following reasons:

(a)—To make dull dyeings brighter (direct or sulfur colors top-dyed with basics).

(b)—To even up off-shade dyeings of different lots, or to improve shades (vat dyeings top-dyed with direct colors).

(c)—Combination dyeings, to increase fastness (indigo dyeings top-dyed with chrome colors).

In (a) and (b), very small amounts of the second dyestuff are involved; in (c), often much larger amounts are concerned.

The author proceeds to outline carefully a definite case of determination of a cotton swatch dyed as under (a). In an abbreviated form, his procedure is as follows:

Reagents, 1 to 2 cc. each; swatch, about 1 square cm.

First Test, Fastness to Washing:

Boil for 2 minutes in 5 per cent soap solution, with a swatch of mercerized cotton. If dyeing is not too light, a direct dyestuff is stripped and goes upon the mercerized cotton. With light dyeings, 1-2 drops of pyridine are added to the soap solution. (Some basics are not fast to washing or soaping.)

Second Test, for a Basic Color (Direct or Sulfur Colors coming Afterward):

Green's method is inconvenient, when small amounts of basic colors are present.

The author's method is to strip with 5 per cent acetic acid as in Green's method, and then to overneutralize with 10 per cent NaOH sol., which with a basic gives either a change in color, or, through formation of a carbinol base, a colorless sol. Then one-half to 1 cc. of benzene is added, and the whole shaken. When the benzene layer has separated, acetic acid of 6° B. is added carefully till the color of the original acetic acid extract returns.

To prove the presence of a basic dyestuff, the already extracted swatch is reboiled with fresh portions of 5 per cent acetic acid, until the last extract is colorless. The swatch is then rinsed and dried. Comparison with another unextracted swatch will show a slightly altered colortone, but no change in depth of tone, which will prove that the goods were top-dyed with a basic.

Practical experience informs us that direct or sulfur colors are the ones almost always top-dyed with a basic.

Third Test, for a Direct Color:

In this test, the presence of Catanol may easily lead one astray, since this mordant contains sulfur. By boiling the swatch with NaOH sol., saturated with NaCl, the Catanol is removed if present, without loss of dyestuff.

A chlorine test, 5 minutes at 30° C. with a 3.5° B. NaOCl sol., will tell us nothing, since both direct and sulfur colors are not fast to this reagent.

But a 2-minute boil with 5 per cent soap sol. will distinguish between the unfast direct color and the fast sulfur color. The swatch is taken from the soap bath, and replaced by a 1 sq. cm. swatch of mercerized cotton, some Glauber salt added, and the whole boiled. If the mercerized cotton becomes colored, and this color is not removed by boiling with fresh soap sol., the dyeing was made with a direct color.

(The paper is to be continued.)

Contribution to Our Knowledge of Wool Dyeing

E. Eloed and A. Koehnlein—Mell. Textil-Ber. 17, 409 (1936.)—The authors quote a statement made in previous papers by the senior author (E.) and his co-workers, to the effect that the process of dyeing (and also of tanning) is really a series of related "partial processes," and that a knowledge of the course of these processes will enable us to grasp and summarize the process as a whole (and otherwise probably not).

In wool dyeing with acid dyestuffs the partial processes go on so rapidly at the high temperature employed that they overlap, or intergrade with, each other, and cannot be traced out as separate processes. One example of this situation is worth quoting: when wool is dyed with acid dyestuffs in a boiling bath acid with hydrochloric acid, it is known that the Cl-ion concentration of the bath does not change during the process. From this fact it has been incorrectly concluded that the Cl-ions play no part in the dyeing process. This viewpoint, expressed by responsible workers, has been proved erroneous by the work of Eloed and his associates, who base their conclusions fundamentally upon the work done by Donnan, which would require the intermediate formation of protein hydrochlorides.

The present paper describes experimental work carried out in reference to the above point. It includes five graphs and two tables. The whole paper is a careful discussion of some aspects of the problem, and is worth reading by those who are interested in the theory of dyeing.

Fatty Alcohol Sulfonates in Hot Baths

Dr. P. Wilhelm—Monats. f. Textil-Ind. 51, 135 (1936). —A short article, giving general practical information as to the use of these agents, but not detailed matter. A useful paper, however.

Degree of Whiteness

(Continued from page 802)

TABLE III

W: Ranks by whiteness values.
F: Ranks by fatty matter content values.
A: Ranks by ash content values.
Numerical figures indicate ranks by visual examination. (1 represents the highest degree of whiteness.)

	H_2O_2		Na_2O_2		NaOCl		$CaOCl_2$	
	I	II	I	II	I	II	I	II
1. Egyptian	W 1	WF 1	W 1	WFA 1	WFA 2	WA 3	WFA 4	W 2
2. Uganda	WF 4	WFA 4	WFA 5	WFA 3	WFA 4	A 5	FA 2	WA 5
3. American	WFA 3	WFA 2	WFA 3	A 2	FA 3	F 1	W 1	WA 1
4. Surat	WFA 2	WA 3	WFA 2	WA 4	WA 1	A 2	WF 3	WFA 3
5. Indian	W 5	WF 5	W 4	WF 5	W 5	WF 4	F 5	WA 4

hypochlorite, and lastly Perchloron take the order of whiteness in bleached samples; whereas for samples of set No. 2 the ranking order is Perchloron, Sodium hypochlorite, Hydrogen peroxide, and finally Sodium peroxide.

3. It is interesting to find from Table III that in either of the two sets, samples bleached with Hydrogen peroxide or Sodium peroxide rank the cottons as regards their whiteness in the order Egyptian, American, Surat, Uganda, and Indian.

4. Furthermore, when Sodium hypochlorite or Perchloron is substituted as a bleaching agent, the cottons then rank in the following order for the degree of whiteness obtained on them—American, Surat, Egyptian, Uganda and Indian.

5. Apart from the effects produced by differential scouring and bleaching treatments, it is proved in Table III that cottons rank with regard to whiteness produced in them in the following order—Egyptian, American, Surat, Uganda and Indian.

6. It is surprising to note that the ash content of the bleached samples, when bleached with Hydrogen peroxide, Sodium peroxide, and Sodium hypochlorite, is the lowest in the case of Indian cotton as compared with other growths. However, it may be noted that the ash content of the cottons when bleached by Perchloron does not give significant results. Nevertheless it may be pointed out that no great reliance may be placed on the values of ash content and residual fatty matter as these are very small and there is a great possibility of experimental error vitiating the deductions.

7. From the finding set out in Table III it is concluded that the whiteness effects by visual examinations are borne out by (1) whiteness values, (2) fatty matter values and (3) ash content values, because in as many as twelve cases all the four systems of ranking have coincided. In fifteen cases two of the aforesaid three values agree well with ranks by visual examinations. Further, in all cases ranks by visual examinations have been substantiated by at least one of the three determinations.

The author's thanks are due to Dr. B. K. Vaidya for his assistance in determining the "Whiteness Values," and to Mr. D. M. Trivedi for carrying out some of the experimental work.

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BOOK REVIEW

Analyse von Faerbungen (Analytical Determination of Dyeings). Dr.-Ing. Eduard Zuehlke. pp. XV + 183, with 16 folding tables. Leipzig; Dr. Max Jaenecke, Verlagsbuchhandlung, 1937.

Dr. Zuehlke's previous work upon the systematic identification of dyestuffs upon the fiber is well known and valued. In this volume, he collects and brings together in one systematic scheme all of his previous experience.

The subject is worked up very fully and in much detail, and the tests, and choice of tests, and interpretation of results, are very fully given. Much incidental information is also added here and there.

It is only natural that a large part of the work deals with the most modern types of the most fast dyestuffs—Indanthrenes and related groups, and Naphthol AS dyeings; and that practically only German and Swiss products are considered. This is not strange, nor, from the author's point of view, at all wrong; if the German and Swiss manufacturers did not satisfy the demands of the Continent with their products, but dyers were obliged to import British or American products for certain kinds of work, doubtless the latter product would have been included also by Dr. Zuehlke. In this country we still are obliged to, or at any rate do, use many products of German or Swiss origin; and so, from our point of view, we wish that Dr. Zuehlke had included in his excellent work a reasonable amount of information regarding our own home products, and some synonymy, after the manner of the Colour Index. As the situation exists, he was, after all, not called upon to do so.

The present manual is still so valuable, in spite of our own personal needs for more, that we believe it to be worth while procuring and annotating; though this presupposes a knowledge of German, which far too few even trained chemists or other sorts of scientists possess, and reasonable opportunities for leisure and careful laboratory and desk work, which too few trained chemists engaged in teaching can hope to obtain.

FREDERICK S. BEATTIE.

TRADE NOTES • NEW PRODUCTS

• KELCO PRODUCTS

The Kelco Company, reported to be one of the largest producers of alginate products in the world and the only producer in the U. S., announces the production of two products for the textile industry which were developed after about 3 years of laboratory research and were introduced to the trade about a year ago. These two products are:

Keltex—a thickening agent for neutral and alkaline printing pastes which is a pure sodium alignate product, said to be made to rigid specifications and, therefore, always of uniform quality. It is said to be entirely free from grit and other foreign impurities. It is claimed to be the ideal thickening agent for neutral and alkaline printing pastes and its cost to be usually much lower than natural gums.

Kelsize—a sodium alginate product for sizing rayon and acetate warps. It is said to give excellent loom performance and to be easily removed by washing.

The Kelco Company sells alginate products to the following industries: food, ice cream, dairy, tooth paste and cosmetic, boiler compound and adhesive. A kelp feed for domestic animals is also produced. It is stated that Kelco products are usable wherever a bodying or thickening agent, a suspending agent, or a stabilizing agent are required. The alginates are extracted from pure Pacific Ocean kelp harvested off the coast of California.

A staff of chemists is maintained to improve old products and develop new ones as well as to give laboratory control of quality to assure uniformity by means of 15 standard control tests of all products during production.

The plant and home offices are located in San Diego, Calif. and branches are maintained in various cities. Sales are direct.

• TAYLOR HANDBOOK

W. A. Taylor & Co., Inc., 872 Linden Ave., Baltimore, Md., has recently issued the new edition of their hand book entitled "Modern pH and Chlorine Control." The first 24 pages of the book are given up to both simple and technical discussions of the meaning of pH control from the standpoint of both colorimetric and electrometric methods. The next 10 pages are devoted to the application of pH control to various problems. The remainder of the book is given over to detailed descriptions of the most modern equipment for control of pH, chlorine and phosphate, and for water analysis. Copies of this hand book are available upon request.

• S.O.C.M.A. MEETING

The regular monthly luncheon and meeting of the Synthetic Organic Chemical Manufacturers Association of the U. S. was held at the Chemists' Club, New York City, on Wednesday, November 17th. Among the items of business discussed at the meeting were the following: resolution on the death of Francis P. Garvan, United Hospital Campaign, reciprocal trades, Doughton Bill, Robinson-Patman Act, imports and educational campaigns. The Annual Meeting of the Association will be held Thursday, December 16th, at the Chemists' Club in New York City, at 12 o'clock noon and will be followed by luncheon.

• JOINS PENNSYLVANIA SALT

Charles B. Griffin, Jr., formerly of the Marshall Field & Company's Manufacturing Division, has recently joined the Technical Service Department of the Pennsylvania Salt Manufacturing Company.

He is a graduate of the Chemical Engineering School of North Carolina State College, and has been associated with Marshall Field for the past four years, working principally in their Textile Manufacturing Division on water purification, bleaching and finishing. During the latter part of this period he was associated with R. A. Butler of Marshall Field's Engineering Department.

His employment by Pennsylvania Salt is in keeping with a company policy to provide technical missionary work for its products in the several consumer market groups.

● HERCULES DIVIDEND

At the regular meeting of the Board of Directors of Hercules Powder Company a year end dividend of 75 cents a share was declared on the 1,310,958 shares of common stock of the company outstanding after giving effect to the split-up of two for one which was voted by stockholders on November 4th, 1937. This dividend is payable December 21st, 1937, to stockholders of record December 10th, 1937.

● GEIGY RELEASE

Geigy Company, Inc., 89 Barclay Street, New York, N. Y. announces release of the following hand book:

Dyestuffs for Wool—a new edition of this popular hand book for the woolen and worsted industries. It is fully modernized in colors illustrated, dyeing methods suggested and fastness properties tabulated. It will make a ready reference for the various dyestuff ranges which are said to provide a color for practically every purpose in the woolen and worsted industries. Included in the colors illustrated are the following classifications: acid colors, fast acid colors, weak acid bath colors, Polar colors, neutral colors and chrome colors. Bulletin 300 D.

● BLICKMAN BULLETIN

S. Blickman, Inc., Weehawken, N. J., has recently issued a circular in which are illustrated and described some new items of equipment which they are manufacturing in stainless steel. This is the second of a series of bulletins to be published on the subject of Stainless Steel Equipment. Among the items featured in this issue are the following: stainless steel dry cans, stainless steel dye mixing tanks, stainless steel rectangular tanks and stainless steel factory-material handling trucks. Copies of the bulletin are available upon request.

● APPOINTED EXECUTIVE DIRECTOR

George A. Urlaub, who has been secretary of the Throwsters' Research Institute, 468 Fourth Ave., New York, N. Y., has been made executive director of the Institute by the Board of Governors. It is stated that the Board of Governors were of the opinion that a great deal of time might be saved and the industry's needs sensed and responded to more quickly and effectively if the Secretary were given broader discretion.

● CYANAMID FOLDER

American Cynamid & Chemical Corp., 30 Rockefeller Plaza, New York, N. Y., has recently issued their newest folder entitled "Products Used in the Textile Industry." This folder lists chemicals and raw materials for the textile industry and, in addition, a partial list of specialties prepared for the textile industry together with a brief description to aid the consumer in determining the products that precisely meet his needs. Copies of this folder are available upon request.

● GENERAL RELEASES

General Dyestuff Corp., 435 Hudson Street, New York, N. Y., announces release of the following circulars:

Fast Orange Salt G G D—representing an addition to the large range of developers of Naphtol A S ground. Valuable orange shades of yellowish character possessing all around fastness including hot pressing are said to be obtainable on Naphtol AS, AS-D, AS-OL, AS-SW and AS-LC ground. Circular I.G. 1373.

Appretan W L—a new finishing agent for rayon. It is said to produce a filling of rayon fabrics or mixtures of cotton and rayon without producing a harsh handle. It is further said to be easily soluble in water and to be neutral in reaction. It is applied only in cold liquors. It may be used with softening agents such as Soramine W L. It is said to be particularly suited for finishing linings of rayon or rayon and cotton. Circular I.G. 1383.

Supra Light Yellow G G L—said to possess a very good fastness to light and to be not only of interest for direct printing but to be of particular interest for colored discharge work. It is stated that its fastness to light and fastness to washing makes it very desirable in cases where the Chinoline Yellows have not been satisfactory. Circular I.G. 1387.

Naphtol AS-DB—said to be a highly substantive brand which was brought out several months ago. It is stated that the most important combinations can be discharged to a clear white and that the combination with Fast Red Salt RC can be resisted to a good white with aluminum sulfate and for colored resists with Algosols. Circular I. G. 1363.

Rapidogen Golden Yellow I F G—said to produce very desirable, bright shades which so far could not be printed with Rapidogen colors. The shades are said to possess excellent fastness to light and very good fastness to washing and chlorine exceeding in this respect all other Rapidogen Yellows which are available. Aside from being very well suited for direct printing alongside Rapidogens and Algosols, the new product is also recommended by the manufacturers for colored resists under Aniline Black or Algosol colors. Circular I.G. 1386.

Direct Silk Blue N R—A direct dyestuff which produces a full navy blue on both vegetable and animal fibers and leaves acetate unstained. The product is said to produce uniform shades on cotton and rayon or wool and silk, both at the boil as well as around 150°F. Circular G-164.

Hydron Blue F B Powder—a Hydron dyestuff which produces brighter shades on cotton than were obtainable up to now with this class of dyestuff. The dyeing method and the fastness properties are the same as the older well known brand, i.e., Hydron Blue RA, GA and BG. Circular I.G. 1407.

● du PONT RELEASES

The following new dyestuffs have been announced by E. I. du Pont de Nemours & Company, Wilmington, Del.:

"Pontamine" Fast Brown SKRL—most recent addition to the du Pont direct colors, is a bright, reddish brown, of a slightly more yellow cast than the "Pontamine" Fast Brown RKL, which it augments. It is designed for hosiery dyeing as well as for use as a union color, and in combination with suitable direct dyes may be employed to produce a wide range of orange and brown shades on cotton, silk and rayon materials. The new dye is described as having satisfactory resistance to washing and light and fastness to chlorine.

"Lithosol" Red 2B Powder—announced as a calcium lake, or toner, was developed for use in printing ink and lacquers when a bright, bluish-red coloring medium of good resistance is required. It has demonstrated suitable fastness to acid, alkali, lacquer solvents and light, the company says, and is non-bleeding in oil, water and alcohol. Tests show it to withstand change when baked at 275 degrees.

Dark Brown R Paste and Brilliant Red B Paste (Patent applied for)—two new "Ponsol" vat colors. "Ponsol" Dark Brown R Paste will be used chiefly as a base for dark brown shades on dress goods, shirtings, towelings and similar cotton and rayon materials, and will also find some application as a shading color. It is said to exhibit general fastness and to be resistant to peroxide bleaching and boiling with soda ash. The shades of brown yielded are somewhat yellower than those of Brown VR Paste.

"Ponsol" Brilliant Red B Paste is expected to be used, the company says, in providing fast colors on cotton, rayon and linen in all forms. It will be used both alone and for shading purposes. Producing bright yellowish shades of red, it is considerably more yellow and somewhat brighter than Red GB Double Paste. The new color is said to be fast to chlorine

and power laundering with chlorine, and resistant to soaping. It is suitable to application in the Franklin machine and by the padding method.

• NOPCO RELEASE

A new softener, known as NOPCO 2105, for acetate and rayon fabrics has been announced by the National Oil Products Company of Harrison, N. J., chemical manufacturers.

The new product is the result of extensive study by research chemists in the company laboratories on chemical composition of textile fibers. The chemists report that only a "fraction of a per cent is sufficient to produce a pleasing, soft hand" on acetates and acetate mixtures.

The Technical Service Department lists three special features of this new finisher. They are (1) pliability; (2) sleekness; (3) softness. It states that NOPCO 2105 does not alter the shade of dyed material, that it is resistant to hard water, oxidation and rancidity, that it does not attack or weaken textile fabrics, that it dissolves completely in hot water, that it is easily applied and that it is stable in acid, alkaline or neutral solutions.

• PHILADELPHIA QUARTZ EXHIBIT

The Philadelphia Quartz Company, established in 1831, manufacturers of silicates of soda, with general offices in Philadelphia, exhibited at the Chemical Exposition in New York, December 6 to 11, the most important of the 33 varieties, liquids, solids and powders, which they make. Silicates of soda have many properties which are not shared by other alkaline salts. Some uses are dependent upon chemical properties of the silicates. An important group of industries, including of course the fiber container, utilizes the adhesive qualities. Another general class of applications include protective or preservative coatings for wood, paper, concrete, etc. Numerous industries make use of the detergent or cleansing quality of metasilicate of soda.

A novel feature of the exhibit was a silicate use meter which helps to visualize the various fields where silicates of soda are useful.

• STATE COLLEGE TEXTILE SCHOOL

Mr. Ernest Walker of the Calco Chemical Company exhibited a sound film depicting the manufacture of dyestuffs made by that company, the operation of various dyeing machines and laboratory methods, to the textile students at the North Carolina State College, on a recent visit to the Textile School.

Mr. T. B. Hayward, who represents Swift & Company Wool Department, of Philadelphia, made an interesting talk to the textile seniors of North Carolina State College. Mr. Hayward has had wide experience in the textile industry and his timely advice was beneficial to all who heard him.

• HERCULES ELECTIONS

At the regular monthly meeting on November 24th, Hercules Powder Company elected four new members to the Board. They are W. R. Ellis, general manager, Explosives Department; Lloyd Kitchel, general manager, Virginia Cellulose Department; P. W. Meyeringh, manager, Foreign Relations Department; and E. B. Morrow. Mr. Morrow, who resigned his position as secretary of the company, also was elected a member of the Finance Committee. Mr. H. F. Smith, secretary to the president, was elected secretary of the company. These elections bring the total membership of the Board of Directors to sixteen. The Board now includes representatives of all main divisions of the company.

• CIBA RELEASES

The following circulars have just been issued by the Society of Chemical Industry in Basle, (Ciba Co., Inc. and Ciba Co. Ltd. sole representatives in U. S. A. and Canada respectively.)

Rosanthrene Orange 2R (Pat.)—this product is said to give shades of considerably redder tone but of decidedly better fastness to light, when developed with either Beta Naphtol or Yellow Developer C. This new dyestuff is suited for dyeing cotton or rayon in all stages of manufacture. The dyeings are said to have a good fastness to washing, perspiration, alkalies, water and sulfuring. Viscose of unequal affinity is dyed in level shades. Acetate fibers are not reserved entirely. Mixed fabrics of cotton and viscose are said to be dyed quite uniformly by Rosanthrene Orange 2R. Silk may be dyed equally well from a soap bath, a neutral bath or from a slightly acidulated bath. Wool-cut staple mixtures may be dyed with Rosanthrene Orange 2R and Cloth Fast Oranges R and G, which produces equal toned dyeings. The dyeings of Rosanthrene Orange 2R are said to be dischargeable to a pure white on cotton, rayon or silk. Circular No. 461.

Migafar P — a new finishing material which is recommended by the manufacturers for the following purposes:

1. Piece goods dyeing.
   (a) For the removal of chafe marks on silk or rayon.
   (b) For avivage, for the production of a fresh, bloomy color tone.
   (c) For levelling out unequal delustering effects.
2. Yarn dyeing.
   As an avivage and for the production of a good scroop.
3. Garment dyeing.
   As an avivage or brightener for silk, rayon, cotton or even woolen garments. Circular No. 469.

Cibacete Discharge Violet 5 R (Pat.)—a straight color of reddish violet shade said to have very good dischargeability. The dyeings are said to have good fastness to water, washing, perspiration acids and crocking. It is stated that Cibacete Discharge Violet 5R is also very level dyeing, so that it may be combined with other dischargeable Cibacete colors like Cibacete Yellow GGR, Cibacete Orange 2R or 4R, Cibacete Scarlets G and BR, Cibacete Reds GR, GGR and B. Cibacete Discharge Violet 5R is suited for the dyeing of mixed fabrics containing cotton or viscose. Wool and silk are somewhat tinted but may be cleared by the ordinary methods. Cibacete Discharge Violet 5R is also adapted for direct or application printing. Circular No. 471.

Cibacete Yellow GGR — a recently introduced dyestuff for dyeing acetates in somewhat redder tones than the older type Cibacete Yellow GGN and is said to be fast to sublimation. Cibacete Yellow GGR is a trifle less fast to light than the GGN type but equal in fastness to the GN type. The new product gives dyeings up to 2½ per cent which are dischargeable to a pure white.

Neolan Yellow 6GE—slightly duller in shade but of decidedly better levelling qualities than Neolan Yellow 6G. Neolan Yellow 6GE is said to be very well suited for dyeing both wool yarns and wool pieces, especialiy as an easy levelling shading color. It exhausts on silk just like Neolan Yellow 6G, but on tin weighted silk somewhat less. The new dyestuff is suited for direct printing on wool, silk and especially on viscose. Dyeings on wool and silk are said to be dischargeable to a pure white with hydrosulfites.

• IN NEW ENGLAND TERRITORY

Frederick N. Spoerl has been appointed to the New England territory by H. W. Butterworth & Sons Company, taking the place of Thomas W. France who represented the company for 33 years and who died suddenly September 26.

Mr. Spoerl has been identified with H. W. Butterworth & Sons Company for 25 years having spent most of this time in the engineering department of the company.

He is a member of the American Association of Textile Chemists and Colorists and is widely known for his work in the Masonic order. During the World War he was a non-commissioned officer and is now a Major, Signal Reserves, being attached to the meteorological division.

OPEN FORUM

Rules under which this department of the REPORTER is conducted are as follows:

1. Anyone who has a technical problem on which he would like advice may submit it to the Reporter and it will be published in the first available issue.

2. Any reader who feels that he has a solution of the problem may forward his reply to us and if we feel that the reply is suitable it will be published in a succeeding issue.

3. For each such reply published the Reporter will pay a minimum of $2.

4. In case there is more than one answer to the same question, the one covering the subject in the most complete and authentic manner will be published, or if two answers are sufficiently different both will be published. If two answers are considered equally good, the one first received will be given priority.

5. The Reporter will assume no responsibility whatsoever for the accuracy of the answers submitted—it is simply offering a vehicle for the public expression of its readers' opinions.

6. Both the questioner and answerer must send in his complete name and address. When requested we will publish only the initials or other identifying insignia.

42—We understand that trisodium phosphate and caustic soda are used for saponifying acetate rayon for printing. Results by this method however are not always satisfactory. We would like information as to how acetate rayon for printing can best be saponified or treated so that it will take direct cotton dyes or developed colors. Information upon this subject will be appreciated.—**W. G.**

Answer

Answer—Although I have no suggestions to make in direct reply to this question, I do feel that it is about time that some emphasis be placed on the possible danger of this practice. In my mind, the trade papers have been calling too much attention to the wonderful possibilities of saponification dyeing with too little mention of the tendency for some acetate warp ends to saponify to a lesser degree than others, resulting in light dyed ends. As yet, neither the acetate yarn manufacturers nor the weaver can control this condition, and because of this fact the converter who authorizes the dyer to saponify these goods does so at his own risk. The same acetate warp yarn when processed as acetate will dye uniformly, but when chemically modified by saponification may or may not show uneven dyeing.

A better understanding of this condition may result in fewer complaints by the converters and dyers.—J. B. G.

New Question

44—We find very often that after goods have been doubled and put on reels that there is a tendency for the silk to cling probably caused by "electricity or magnetism."

Any information that readers of the Open Forum may give as to practical methods of eliminating this trouble will be highly appreciated.—**W. D. P. B.**

CLASSIFIED

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